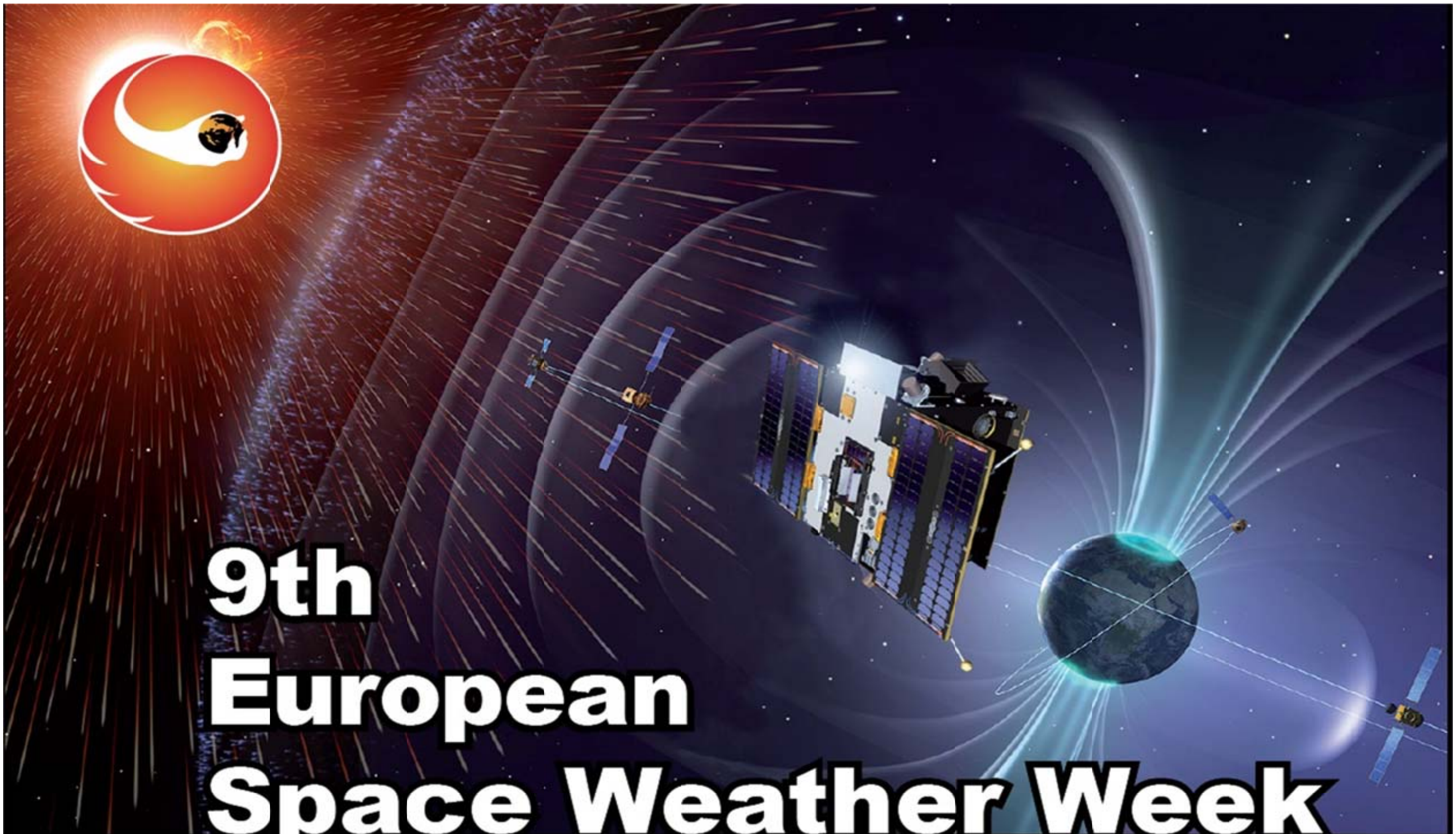

9th European Space Weather Week

November 5 - 9, 2012
Brussels, BELGIUM

Abstract book & Final programme

STCE esa COST ES0803 belspo RHEA cost

SWSC Journal of Space Weather and Space Climate

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EISCAT Scientific Association

http://www.eiscat.com/

Ninth European Space Weather Week

Programme

Monday, 5 November 2012
09:00-17:30

10.00 Start Tutorial

11.00 Coffee break

11:30 Continue Tutorial

12:30 Lunch break

13:30 Welcome & Opening
Room: Auditorium ALBERT II

Session 1: European Space Weather Landscape: Current Perspectives and Requirements for the Future
Chairs: S. Lechner (JRC) & J-P Luntama (ESA)
Room: Auditorium Albert II

16:00 *Coffee break and Poster Session 1*

16:45 The Solar Tsunami Warning System

Bothmer, Volker [1]; McInnes, Colin R. [2]; Hilgers, Alain [3]; Viereck , Rodney [4]; Vourlidas, Angelos [5]; Howard, Russell A. [6]; Harrison , Richard A. [7]; Rodmann , Jens [1]; Bosman , Eckhard [1]

[1]Institute for Astrophysics / University of Goettingen, (GERMANY); [2]Department of Mechanical and Aerospace Engineering / University of Strathclyde, (UNITED KINGDOM); [3]Space Environment and Effects Section (TEC/EES) / ESA/ESTEC, (NETHERLANDS); [4]NOAA Space Weather Prediction Center, (UNITED STATES); [5]Solar Physics Branche Naval Research Laboratory, (UNITED STATES); [6]Solar Physics Branche, Naval Research Laboratory, (UNITED STATES); [7]STFC Rutherford Appleton Laboratory, (UNITED KINGDOM).. 37

17:00 Helio, a new Tool for space Weather.

Aboudarham, Jean [1]; Bentley, Robert D. [2]; Csillaghy, André [3]; Gallagher, Peter [4]; Hapgood, Mike [5]; Messerotti, Mauro [6]; Jacquey, Christian [7]; Bocchialini, Karine [8]; Brooke, John [9]

[1]Observatoire de Paris, (FRANCE); [2]MSSL/UCL, (UNITED KINGDOM); [3]FHNW, (SWITZERLAND); [4]TCD, (IRELAND); [5]STFC, (UNITED KINGDOM); [6]INAF/Trieste, (ITALY); [7]UPST, (FRANCE); [8]IAS/UPS, (FRANCE); [9]University of Manchester, (UNITED KINGDOM).. 38

17:15 Empirical Approach to predict geomagnetic Disturbances Relevant to GIC

Wintoft, Peter [1]; Wik, Magnus [2]; Lundstedt, Henrik [1]; Eliasson, Lars [1]

[1]Swedish Institute of Space Physics, (SWEDEN); [2]NeuroSpace, (SWEDEN 38

17:30 End of Plenary session in the Palais des Académies

18:30 Arrival of the guests at Egmont Palace
Address:
Petit Sablon 8
1000 BRUXELLES

18:30 Keynote lecture in Arenberg Room
Professor Jocelyn Bell Burnell

19:35 Start Welcome reception in the Hall of Mirrors

Tuesday, 6 November 2012
09:00-12:30

Session 2 Innovations and Key Challenges in Space Weather Science
Chairs: V. Bothmer (Univ. Goettingen) & J. Moen (Univ. Oslo)
Room: Auditorium Albert II

09:00 Lessons learnt from the STEREO Heliospheric Imagers: Tracking and modelling CMEs from Sun to Earth
Harrison, Richard ; Davies, Jackie ; Davis, Chris ; Eyles, Chris ; Crothers, Steve
Rutherford Appleton Laboratory, (UNITED KINGDOM).. 38

09:15 SOHO/UVCS and STEREO comparative Analisys of a Coronal Mass Ejection
Susino, Roberto [1]; Bemporad, Alessandro [1]; Vourlidas, Angelos [2]; Dolei, Sergio [3]
[1]INAF - Osservatorio Astrofisico di Torino, (ITALY); [2]Naval Research Laboratory, (UNITED STATES); [3]INAF - Osservatorio Astrofisico di Catania, (ITALY).. 38

09:30 Studying CME-Dust particle Interactions and their possible Applications to forecasting the Geo-Effectiveness of ICMEs
Rodmann, Jens [1]; Bothmer, Volker [2]; Hesemann, Jonas [2]; Wolf, Sebastian [3]
[1]University of Goettingen, (GERMANY); [2]University of Goettingen, Institute for Astrophysics, (GERMANY); [3]University of Kiel, Institute for Theoretical Physics and Astrophysics, (GERMANY).. 39

09:45 Forecasting the High Energy Electron Radiation Belts within the FP7 SPACECAST Project
Horne, Richard [1]; Glauert, Sarah A. [1]; Meredith, Nigel P. [1]; Boscher, Daniel [2]; Maget, Vincent [2]; Sicard, Angelica [2]; Heynderickx, Daniel [3]; Pitchford, David [4]
[1]British Antarctic Survey, (UNITED KINGDOM); [2]ONERA, (FRANCE); [3]DH Consultancy, (BELGIUM); [4]SES Global, LUXEMBOURG).. 39

10:00 New tools to relate Imagery with in-situ Data and their Application to space-weather Forecasting:
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[1]IRAP, (FRANCE); [2]IRAP/CDPP, (FRANCE); [3]GMU/GSFC, (UNITED STATES).. 40

10:15 NASA GSFC Space Weather Center - Innovative Space Weather Dissemination: web-Interfaces, mobile Applications, and more.
Maddox, Marlo [1]; Zheng, Yihua [1]; Rastaetter, Lutz [2]; Taktakishvili, A. [2]; Mays, M.L. [2]; Kuznetsova, M. [2]; Lee, Hyesook [3]; Chulaki, Anna [2]; Hesse, Michael [2]; Mullinix, Richard [2]; Berrios, David [2]; Pulkkinen, Antti [4]
[1]NASA Goddard Space Flight Center, (UNITED STATES); [2]NASA/GSFC, (UNITED STATES); [3]NASA/GSFC and KMA, (KOREA, REPUBLIC OF); [4]NASA/GSFC and CUA, (UNITED STATES).. 40

10:30 Splinter Wrap-up
Room: Auditorium ALBERT II

10:45 Coffee break & Poster Session 2

11:30 Status of the Kjell Henriksen Observatory (KHO) auroral forecast Service
Sigernes, F. [1]; Holmen, S. E. [1]; Dyrland, M. [1]; Baekken, A. L. [2]; Brekke, P. [3]; Chernouss, S. [4]; Lorentzen, D. A. [1]; Deehr, C. S. [5]
[1]University Centre on Svalbard (UNIS), (NORWAY); [2]University of Oslo, (NORWAY); [3]Norwegian Space Centre, (NORWAY); [4]Polar Geophysical Institute, Apatity, (RUSSIAN FEDERATION); [5]Geophysical Institute, University of Alaska, (UNITED STATES).. 40

11:45 Real-time scintillation Monitoring at high-Latitudes
Schäfer, Sebastian ; Jacobsen, Knut Stanley
Norwegian Mapping Authority, (NORWAY) *41*

12:00 The Space Weather Hazard to the UK Electricity Transmission System: A 2012 Update
Thomson, Alan W P ; Beggan, Ciaran D ; Beamish, David ; Kelly, Gemma S
British Geological Survey, (UNITED KINGDOM) *41*

12:15 Interpolation and Cassification of geomagnetic Variations using neural Network Techniques
Wik, Magnus [1]; Wintoft, Peter [2]
[1]NeuroSpace, (SWEDEN); [2]Swedish Institute of Space Physics, (SWEDEN) *42*

12:30 Lunch break

Tuesday, 6 November 2012
14:00-19:30

14:00 Splinter Session

Room Auditorium Albert II	**Room** Roi Baudouin	**Room** Claire Préaux
Forecaster Forum I *L. Trichtchenko (NRCan)*	Ground Effects topical group *M. Wik (Neurospace)*	PROBA2 LYRA *M. Dominique (STCE)*

16.00 *Coffee break*

16.30 Splinter Session

Room Auditorium Albert II	**Room** Roi Baudouin	**Room** Claire Préaux
Forecaster Forum II: a case study *L. Trichtchenko (NRCan)* *D. Pitchford (SES Astra)* *H. Evans (ESA)*	Education, Outreach and Emerging Markets *N. Crosby (BIRA-IASB))*	PROBA2 SWAP *D. Berghmans (STCE)*

18.30 Start Debate: Safe Space - Is a programme for the removal of space debris necessary?
Room: Trone

The discussion panel

The members of the discussion panel are all experts in the field. The following panel members will present their view on the topic.

- Fernand Alby at CNES [expert on orbital debris]
- Olivier Colaitis at Astrium [expert on orbital debris]
- Stuart Eves at Surrey Satellites [expert on space traffic control]
- Jean-Francois Mayence at BELSPO [legal expert on space issues]
- Emmet Fletcher at ESA [SSA Survey and Tracking Manager]
- Hugh LEWIS at University of Southampton

The moderator: Frank Burnet

19.30 End of day

Wednesday, 7 November 2012
09:00-12:30

Session 3a Solar Variability Effects on Climate
Chairs: T. *Dudok de Wit (Univ. Orléans) & K. Matthes (GEOMAR);W. Schmutz (PMOD)*
Room: Auditorium Albert II

Wednesday, 7 November 2012
09:00-12:30

Session 3b Coupled Space Weather Modelling
Chairs: G. Lapenta (KULeuven) & A. Aylward (UCL, UK)
Room: Roi Baudouin

09:00 The deep Project
Eicker, Norbert
Forschungszentrum Jülich, (GERMANY) 45

09:20 Increasing the domain Size of kinetic Simulations: a multi level multi domain Method for Plasma Simulations
Innocenti, Maria Elena [1]; Beck, Arnaud [1]; Lapenta, Giovanni [1]; Markidis, Stefano [2]; Vapirev, Alexander [1]
[1]KULeuven, (BELGIUM); [2]KTH Royal Institute of Technology, (SWEDEN) 45

09:40 A 3D Global Magnetohydrodynamic Simulation of the Solar Wind/Earth's Magnetosphere Interaction
Yalim, Mehmet Sarp ; Poedts, Stefaan
KU Leuven, (BELGIUM) 46

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Raeder, Jimmy [1]; Li, Wenhui [1]; Gilson, Matthew [1]; Fuller-Rowell, Tim [2]; Fok, Mei-Ching [3]
[1]University of New Hampshire, (UNITED STATES); [2]NOAA/SWPC, (UNITED STATES); [3]NASA/GSFC, (UNITED STATES) 46

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Pierrard, Viviane ; Borremans, Kris
Belgian Institute for Space Aeronomy, (BELGIUM) 46

10:30 Splinter Wrap-up
Room: Auditorium ALBERT II

10:45 Coffee break & Poster Session 3

11:30 Test particle Simulations of Solar Energetic Particle Propagation for Space Weather
Marsh, Mike ; Dalla, Silvia ; Kelly, James ; Laitinen, Timo
University of Central Lancashire, (UNITED KINGDOM) 47

11:45 Coupled global Modeling of SEP Acceleration in a coronal CME/Shock and subsequent interplanetary Transport to AU
Kozarev, Kamen [1]; Evans, Rebekah [2]; Schwadron, Nathan [3]; Dayeh, Maher [4]; Opher, Merav [5]; Korreck, Kelly [1]
[1]Smithsonian Astrophysical Observatory, (UNITED STATES); [2]NASA/GSFC, (UNITED STATES); [3]University of New Hampshire, (UNITED STATES); [4]Southwest Research Institute, (UNITED STATES); [5]Boston University, (UNITED STATES) 47

12:00 Solar energetic particle Simulations in SEPServer - How to deal with scale Separation of thirteen Orders of Magnitude
Vainio, Rami [1]; Afanasiev, Alexander [1]; Agueda, Neus [2]; Battarbee, Markus [3]; Ganse, Urs [4]; Kilian, Patrick [4]; Pomoell, Jens [1]; Sanahuja, Blai [2]; Spanier, Felix [4]; Valtonen, Eino [3]
[1]University of Helsinki, (FINLAND); [2]University of Barcelona, (SPAIN); [3]University of Turku, (FINLAND); [4]University of Würzburg, (GERMANY) 48

12:15 Satellite Orbits and ATMOP: improving thermospheric density Modelling through Data Assimilation
Henley, Edmund
Met Office, (UNITED KINGDOM) 48

12:30 Lunch break

Wednesday, 7 November 2012
14:00-18:30

14.00 Splinter Session

Room *Roi Baudouin*
SWWT *S. Poedts (CPA)*

16.00 ***Coffee break***

16.30 Space Weather Fair
Room: Patio

17.30 Start Beer Tasting
Room: Patio

19.30 End of day

Thursday, 8 November 2012
09:00-12:30

Session 4a Spacecraft Operations and Space Weather
Chairs: R. Horne (British Antarctic Survey, UK) & D. Pitchford (SES)
Room: Auditorium Albert II

10:30 Splinter Wrap-up
Room: Auditorium ALBERT II

10:45 Coffee break & Poster Session 4

12:30 Lunch break

Thursday, 8 November 2012
09:00-12:30

Session 4b Space Weather in the Solar System
Chairs: A*. Coustenis & V. Dehant (ROB)*
Room: Roi Baudouin

09:00 Space Weather in the solar System
Coates, Andrew
University College London, (UNITED KINGDOM).. 50

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Coates, Andrew [1]; Bunce, Emma [2]; Krupp, Norbert [3]; Dougherty, Michele [4]; Grasset, Olivier [5]; Coustenis, Athena [6]; Blanc, Michel [7]; Coradini (dec), Angioletta [8]; Drossart, Pierre [6]; Fletcher, Leigh [9]; Hussmann, Hauke [10]; Jaumann, Ralf [10]; Prieto-Ballesteros, Olga [11]; Tortora, Paolo [12]; Tosi, Federico [8]; Van Hoolst, Tim [13]; Titov, Dima [14]; Erd, Christian [14]
[1]University College London, (UNITED KINGDOM); [2]University of Leicester, (UNITED KINGDOM); [3]MPS, (GERMANY); [4]Imperial College London, (UNITED KINGDOM); [5]University of Nantes, (FRANCE); [6]Meudon Observatory, (FRANCE); [7]Ecole Polytechnique, (FRANCE); [8]INAF, (ITALY); [9]University of Oxford, (UNITED KINGDOM); [10]DLR, (GERMANY); [11]INTA-CSIC, (SPAIN); [12]University of Bologna, (ITALY); [13]Royal Observatory of Belgium, (BELGIUM); [14]ESA/ESTEC, (NETHERLANDS) 50

09:45 Physics-based Modeling of the Variations of the solar EUV Spectrum
Haberreiter, Margit [1]; Delouille, Veronique [2]; Ermolli, Ilaria [3]; Verbeeck, Cis [2]; Qahwaji, Rami [4]
[1]PMOD/WRC, (SWITZERLAND); [2]ROB, (BELGIUM); [3]INAF, (ITALY); [4]University of Bradford, (UNITED KINGDOM) . 51

10:00 Solar energetic Particles and associated Phenomena in Radio and EUV Wavelengths
Miteva, Rositsa [1]; Klein, Karl-Ludwig [1]; Kienreich, Ines [2]; Veronig, Astrid [2]; Samwel, Susan W. [3]
[1]Observatoire de Paris, CNRS, (FRANCE);
[2]IGAM/Institute of Physics, University of Graz, (AUSTRIA); [3]National Research Institute of Astronomy and Geophysics, (EGYPT) 51

10:15 The Origins and heliospheric Evolution of CMEs on 7 and 14 August 2010 originating from the same solar source Region
Steed, Kimberley [1]; Long, David [2]; Walsh, Andrew [2]; Lapenta, Giovanni [1]
[1]KU Leuven, (BELGIUM); [2]Mullard Space Science Laboratory, University College London, (UNITED KINGDOM) ... 51

10:30 Splinter Wrap-up
Room: Auditorium ALBERT II

10:45 Coffee break & Poster Session 4

11:30 Dications and thermal Ions in planetary atmospheric Escape
Lilensten, Jean [1]; Simon Wedlund, Simon [2]; Barthélémy, Mathieu [3]; Thissen, Roland [3]; Ehrenreich, David [3]; Gronoff, Guillaume [4]; Witasse, Olivier [5]
[1]CNRS/UJF, (FRANCE); [2]Belgian Institute for Space Aeronomy (BIRA-IASB), Brussels, (BELGIUM); [3]IPAG, (FRANCE); [4]NASA, (UNITED STATES); [5]RSSD-ESA, (NETHERLANDS)... 51

11:45 Prediction of ICME Arrival at Mars
Vennerstrom, Susanne [1]; Falkenberg, Thea V. [1]; Leer, Kristoffer [1]; Veronig, Astrid [2]; Vrsnak, Bojan [3]; Odstrcil, Dusan [4]
[1]Technical University of Denmark, (DENMARK); [2]Ubiversity of Graz, (AUSTRIA); [3]University of Zagreb, (DENMARK); [4]NASA GSFC, George Mason University, (UNITED STATES) 52

12:15 Comparative planetology Study of extreme solar Events: Mars, Venus, Titan, Earth
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[1]NASA LaRC, (UNITED STATES); [2]BIRA, (BELARUS); [3]Boston University, (UNITED STATES); [4]Eastern Michigan University, (UNITED STATES); [5]University of Michigan, (UNITED STATES); [6]LASP / APS / CU Boulder, (UNITED STATES); [7]SSL Berkeley, (UNITED STATES) 52

12:30 Lunch break

Thursday, 8 November 2012
14:00-17:30

14.00 Splinter Session

Room *Auditorium Albert II*	**Room** *Roi Baudouin*	**Room** *Claire Préaux*	**Room** *Jules Bordet*
Coupled Space Weather Modelling *G. Lapenta (CPA), A. Aylward (UCL)*	Ionospheric Effects Topical Group *M. Angling (QinetiQ)*	Solar Storms: Solar Energetic Particle (SEP) events *O. Malandraki (NOA*	European Space Weather Business Group *M. Wik (NeuroSpace)* *D. Heynderickx (DH Consultancy)*

16.00 Coffee break

16.30 Splinter Session

Room *Auditorium Albert II*	**Room** *Roi Baudouin*	**Room** *Claire Préaux*	**Room** *Jules Bordet*
Scientific requirements for Space Environment forecasting Models *R. Horne (British Antarctic Survey, UK)* *I. Daglis (NOA)*	Atmospheric Effects Topical Group *S. Bruinsma (CNES)*	Spacecraft, Aircraft and Launcher Topical Group *S. McKenna (NUI)*	CASSIS *D. Berghmans (STCE)* *R.D. Bentley (Univ. College London)* *M. Messerotti (INAF/COST ES0803)*

17:30 End of day

19:30 Conference Dinner

Hotel Bedford
135-137, rue du Midi
1000 Brussels

The dinner will take place on the second floor, in the Foyer John Glenn and Armstrong Room.

Friday, 8 November 2012
09:00-13:30

Session 5 COST ES0803 Final Results
Chairs: *A. Belehaki (NOA) & M. Messerotti (INAF)*
Room: Auditorium Albert II

09:00 Advanced methods to model and predict space weather effects - Summary of Progress
Watermann, J.
jfwConsult, (BELGIUM) *54*

09:20 Solar activity and its evolution across the corona
Zuccarello, F.
Università di Catania, (ITALY) *54*

09:40 Solar activity impact on the Earth's upper atmosphere
Kutiev, I.
National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences, (BULGARIA) *54*

10:00 Space Weather Challenges of the polar cap Ionosphere
Moen, Joran [1]; Oksavik, Kjellmar [2]; Alfonsi, Lucilla [3]; Barthémely, Mathieu [4]; Daabakk, Yvonne [5]; Lilensten, Jean [4]; Romano, Vincenzo [3]; Spogli, Luca [3]
[1]University of Oslo, (NORWAY); [2]Department of Physics and Technology, University of Bergen, (NORWAY); [3]Istituto Nazionale di Geofisica e Vulcanologia, (ITALY); [4]LPG, CNRS and Joseph Fourier University, (FRANCE); [5]Department of Physics, University of Oslo, (NORWAY) *54*

10:20 Verification of space weather models
Wintoft , P. ; Buresova, D. ; Bushell, A. ; Hejda, P. ; Innocenti, M.E. ; Lapenta, G. ; Nunez, M. ; Perrone, L. ; Qahwaji, R.; Thomson, A. ; Tsagouri, I. ; Valach, F. ; Viljanen, A.
IRF, (SWEDEN) *54*

10:40 Splinter Wrap-up
Room: Auditorium ALBERT II

10:55 Coffee break & Poster Session 5

11:30 Progress in space weather modeling in an operational environment
Tsagouri, I.
National Observatory of Athens, (GREECE) *54*

11:50 Recommendations for space weather products and services in Europe
Van der Linden, R. [1]; Hapgood , M. [2]; Heynderickx , D. [3]; Stanislawska , I. [4]; Belehaki , A. [5]; Messerotti , M. [6]
[1]Royal Observatory of Belgium, (BELGIUM); [2]RAL, (UNITED KINGDOM); [3]DHC, (BELGIUM); [4]SRC, PAC, (POLAND); [5]NOA, (GREECE); [6]INAF, (ITALY) *55*

12:10 Where communication and space weather meet
Vanlommel, Petra
Solar-Terrestiral Centre of Excellence-STCE, (BELGIUM) *55*

12:30 "Networking for space weather outreach activities: the Planeterrella example"
Lilensten, Jean [1]; Barthélémy, M. [1]; Simon, C. [1]; Gronoff, G. [2]
[1]Institut de Planétologie et d'Astrophysique de Grenoble (IPAG), (FRANCE); [2]Institut de Planétologie et d'Astrophysique de Grenoble (IPAG), ... *55*

12:50 Closing session

13.30 End of conference

Poster sessions

The posters will remain on display the whole week. Authors are requested to be in attendance during the following slots as marked in the agenda:

Posters 1: Session 1
Posters 2: Session 2
Posters 3: Session 3A & 3B
Posters 4: Session 4A & 4B
Posters 5: Session 5

Monday, 5 November 2012

Poster session 1

Tuesday, 6 November 2012

<u>Poster session 2</u>

Wednesday, 7 November 2012

Poster session 3A

Wednesday, 7 November 2012

Poster session 3B

Thursday, 8 November 2012

Poster session 4A

Thursday, 8 November 2012

Poster session 4B

Thursday, 8 November 2012

Poster session 5

ABSTRACTS

EU space weather research in FP7 and in the future

Malacarne, Marco
European Commission
DG Enterprise and industry

The presentation will give an overview of the Space Weather related actions funded under the EU 7th framework programme for research. These actions cover a wide range of topics including science, modelling and forecasting, terrestrial effects as well as technology development. The presentation will also outline the role of space research and space weather research in the future EU research programme Horizon 2020.

ESA views on the future SSA-SWE activities in Europe

Bobrinsky, Nicolas; Luntama, Juha-Pekka; Glover, Alexi
ESA/ESAC, Spain

European Space Agency has been performing space weather related studies and activities actively for almost 15 years. Start of the SSA Preparatory Programme and the development of the SSA Space Weather Segment in 2009 was an important milestone during this period. Now the first ESA SSA-SWE service developments have been completed, the SSA-SWE precursor services are available for the user community to test and validate, and very important analysis of the space weather assets in Europe and hosted payload flight opportunities have been carried out. This presentation provides an overview of how ESA foresees the continuation of space weather activities within the SSA Programme and also within other programmes in the Agency.

Introduction to WMO space weather activities

Zhang,Wenjian
WMO, Director of the Observing and Information Systems Department

Although the primary scope of activity of the WMO is atmospheric weather, climate, hydrology and related sciences and applications in support of protection of life and property and socio-economic well-being, the WMO has started to be involved in Space Weather since 2008, upon request of several of its Members and of the International Space Environment Service (ISES). The aim is to build on WMO's experience of global operational services in order to support the coordination of emerging space weather information services.

Space Weather is important for WMO as it impacts key elements of the meteorological infrastructure – observation satellites and telecommunications. It also directly affects some of its core users (e.g. aviation), which suggests the possibility of integrated warning services. WMO can support space weather observation – e.g. aboard meteorological satellites – and communications, through its worldwide information system.

To-date, experts from 18 countries and 7 international organizations are participating in the WMO Inter-programme Coordination Team on Space Weather (ICTSW). Over the past two years, activities have been focused on key elements of the information chain from observation to service delivery:
- Developing an initial set of observation requirements,
- Reviewing the available and planned observing capabilities,
- Identifying observation gaps and priority actions to fill these gaps and secure continuity,
- Selecting operational products that are made available on a portal for demonstration purposes,
- Data exchange and data management issues in the context of the WMO Information System,
- Collaboration with the International Civil Aviation Organization (ICAO) on the future concept of operational space weather services to international air navigation,

The presentation will address some of the challenges to be faced on the road towards establishing a "global framework for operational space weather services", building on the successful approach that has led to a robust, globally coordinated weather monitoring and prediction system. WMO looks forward to be a facilitator in this respect, in collaboration with international partners such as ISES, ESA and the European Union, and with national organizations involved in this domain.

NOAA – EU Space Weather Cooperation

Onsager, T. G.
NOAA Space Weather Prediction Center

Space weather is entering an important era of expanded international coordination. Although our understanding of the Sun-Earth environment has improved considerably over the past decades, our vulnerability to space weather has also increased due to growth in our reliance on technologies impacted by space weather. Around the globe, industry and government sectors are becoming more engaged in developing mitigating strategies and in assessing risks. International interest in providing space weather services is increasing, and various organizations are working to coordinate the effort. A key issue going forward is understanding how we can build on the foundation for collaboration that has been established and implement the needed improvements to our observing capabilities and to our services.
In this presentation, NOAA's growing collaborations with the European Union will be summarized along with our

priorities for future development and participation in broader international efforts.

Roadmaps for Future Operational Space Weather Services

Valdes Solorzano, Omar Ignacio[1]; Lawrence, Gareth[1]; Watermann, Jurgen[1]; de Donder, Erwin[2]; Kruglanski, Michel[2]; Berghmans, David[3]; Robbrecht, Evan[3]; Danielides, Michael[4]
[1]RHEA System; [2]Belgian Institute for Space Aeronomy; [3]Royal Observatory of Belgium; [4]German Space Agency

We present the results of a study, conducted by RHEA and international partners, in which strategic Roadmaps for the development of a fully operational space weather system have been prepared.

37 Operational Space Weather Services have been specified to meet identified user needs as part of ESA's Space Situational Awareness (SSA) programme. Only a portion of these are offered today by existing European Infrastructure. Significant developments are needed in the areas of space weather sensors, scientific research, system and software engineering to reach the defined objectives.

The study has defined a set of Service Requirements – detailed objective specifications for each identified service. The requirements have then been considered against a comprehensive list of existing European assets. Each Roadmap proposes the steps needed to evolve towards fully operational services in the medium and long term, taking full account of programme goals to maximise use of European expertise following a federated approach.

A summary of the main findings, including lessons learned will be presented.

The Solar Tsunami Warning System

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The prime causes of major geomagnetic storms are fast solar coronal mass ejections (CMEs) and solar wind high speed streams, including the appearance of compound flows caused by stream interactions during their heliospheric evolution, e.g. in the case of multiple interacting CMEs with different propagation speeds. EUV and white-light remote sensing observations of the Sun's corona and photospheric fields, providing CME alerts and information on their source region locations, propagation speeds, near Sun evolution and magnetic field structure, are a necessary ingredient of any dedicated space weather forecast system. The development of sensitive wide-angle cameras, such as the Heliospheric Imagers of the SECCHI telescope suite on board the twin STEREO spacecraft, has enabled for the first time the tracking of CMEs over the entire distance from Sun to Earth. Building on the experience from STEREO, two satellites at a suitable separation angle with respect to the Sun-Earth line or in the Lagrangian L5 and L4 orbits would provide alerts of earthward directed CMEs and their tentative arrival times as well as the arrival of high speed streams. The spacecraft in the orbit trailing Earth would provide measurements of the co-rotating stream pattern about 4 days ahead of their passage over the Earth and on the solar wind structure into which a CME directed to Earth would be propagating. Since the intensity of solar energetic particle (SEP) events depends on the magnetic connection to the acceleration source region sites at the Sun and since CMEs originating in the Sun's western hemisphere are more likely to be swept across the Earth due to their interaction with the ambient solar wind, which make the observations of the coronal structure provided by the spacecraft leading Earth orbit a key measurement target. Because remote sensing observations alone can not provide fully quantitative forecast of the upcoming geomagnetic storm levels, and because of their dependence on the evolution of the CME and solar wind stream plasma and magnetic field parameter in the inner heliosphere, in situ solar wind measurements ahead of the Earth's magnetosphere, such as currently provided by the ACE satellite in L1, are another cornerstone of a space weather warning system that aims at providing reliable space weather forecasts. Since in the most severe space storms in history, termed "Carrington events", the CME travel times were less than a day, it would be of prime importance to help increase the prediction accuracy of the arrival time of CMEs at Earth and to measure in advance their precise plasma and magnetic field parameters. Solar sail technology has substantially developed over the past decade and the solar sail technology demonstration project "Sunjammer", heading for a sub L1 orbit, has just been approved by NASA as a technology demonstration mission to be ready for a 2014 launch. Using solar sail technology the DLR, ESA in a solar sail technology roadmap, a "displaced L1" solar sail mission scenario is under development. A spacecraft in DL1 could help double the warning time of the onset of space storms and provide the necessary measurements of the upcoming geomagnetic storm levels and the time evolution of the storm. The Lagrangian 3-D spacecraft trio in DL1, L4 and L5, equipped with suitable instrumentation, would provide in this way alerts of earthward directed CMEs with 12 hours as a lower minimum in time for cases of extreme fast CMEs, followed by the subsequent in situ DL1 measurements, providing half an hour to 1.5 hour ahead information on the real parameters of the "Solar Tsunami" wave passing over the DL1 buoy. This mission scenario "The Solar Tsunami Warning System" will be complemented by real time CME modeling, e.g. by the Graduated Cylindrical Shell (GCS) technique applied to beacon data and simulations of the solar wind streams by sophisticated codes, such as ENLIL.

Helio, a new Tool for space Weather.

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HELIO is a research infrastructure funded by the European Community under the FP7 I3 program; it involves a consortium of 13 European and US partners.

The project provides a wide access to dozens of solar and heliospheric databases scattered all around the world. A set of services allows the user to constraint queries based on a number of criteria. It is then possible to select not only data by observing time, but also by instrument characteristic, location in the solar system, etc.

The HELIO system provides added values such as an event catalogue, which gives a centralised access to several event catalogues and connect their results to other kinds of queries and a feature catalogue giving information on the behaviour of solar and heliospheric features extracted using automatic features recognition codes. Moreover, a propagation model allows the user to connect data from various places of the solar system, giving the opportunity to follow phenomena propagating through the solar system.

As the HELIO finishes at the end of 2012, the prototype is now fully operational, and users can already find information on the HELIO web page (http://www.helio-vo.eu/) and access and test the user interfaces at will.

Empirical Approach to predict geomagnetic Disturbances Relevant to GIC

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[1]Swedish Institute of Space Physics; [2]NeuroSpace

The upstream solar wind interacts with Earth's magnetosphere causing geomagnetic storms primary driven by shocks and the turning of the IMF to negative Bz. During these events the local magnetic field, measured at ground stations, show a large degree of fluctuation from the highest measured resolution (seconds) to several minutes. These fluctuations induce electrical currents (GIC) in power grids, where the level of GIC is also determined by the ground conductivity. In this work we describe the available solar observations and derived data, solar wind measurements, and geomagnetic events in terms of dB/dt and empirical models for warnings and forecasts relevant for GICs. The forecasts are evaluated in real time against geomagnetic data from observatories in Europe. The models are implemented at Regional Warning Center-Sweden. The work is partly funded by the EU/FP7 project EURISGIC and the MSB project "Solar storms and space weather".

Lessons learnt from the STEREO Heliospheric Imagers: Tracking and modelling CMEs from Sun to Earth

Harrison, Richard; Davies, Jackie; Davis, Chris; Eyles, Chris; Crothers, Steve

Rutherford Appleton Laboratory

The two STEREO spacecraft were launched in late 2006. Since that time we have had unprecedented views of CMEs travelling through the inner heliopshere using wide-angle imaging with the Heliospheric Imagers (HI). We now have over five years of observations of CMEs in the heliosphere and have developed a range of tools for event identification, modelling and prediction. Here, we review the status of this work and provide pointers to future projects stemming from the HI experiences.

SOHO/UVCS and STEREO comparative Analisys of a Coronal Mass Ejection

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Our study focuses on the analysis of one interesting Coronal Mass Ejection (CME) detected by both SOHO/UVCS and STEREO on May 20, 2007. The event was a partial-halo CME associated with a prominence eruption, ejected form an active region (AR NOAA 10956) located close to the solar disk center, with a B9 class flare and a type-II radio burst. It produced a very symmetric, quite faint, hemispherical white-light front observed by SOHO and STEREO coronagraphs (at that time the angle between the STEREO A and B spacecrafts was about 8.8°). Moreover, the erupted flux-rope gave rise to a magnetic cloud, which was observed in situ by STEREO and WIND, and triggered significant geomagnetic storms since May 22.

We show that the UV spectral line emission derived by UVCS data during the CME propagation is blue-shifted up to velocities of 650 km/s (along the LOS), much larger than the velocities on the plane of the sky as inferred from LASCO/C2 images (150 km/s). The kinetic temperature of the oxygen ions in the CME front as inferred from O VI 1032Å/1037Å doublet line profiles is about 9 MK, lower than the kinetic temperature of the undisturbed pre-CME corona.

The preliminary 3D reconstruction of the expanding front with pB ratio technique (applied to STEREO/COR1 and SOHO/LASCO data) and the 3D reconstruction of prominence trajectory via triangulation technique (applied to STEREO/EUVI data) are complemented by the constraints on the 3D expansion provided by the UVCS spectra. Reconstruction of the CME's 3D kinematic constrained by both coronagraphic and spectroscopic data is of fundamental importance for possible applications in the geomagnetic storms forecastings.

Studying CME-Dust particle Interactions and their possible Applications to forecasting the Geo-Effectiveness of ICMEs

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Assessing the geo-effectiveness of Earth-bound interplanetary coronal mass ejections (ICMEs) and increasing the advance warning time is one of the key challenges in space weather forecasting. The main parameters determining the intensity of a geomagnetic storm are the ICME velocity vector and magnetic field configuration. Fast ICMEs and southward-pointing magnetic field (Bz < 0) are thought to be necessary conditions for major geomagnetic storms.

While the speed, and hence the arrival time, of CMEs/ICMEs en route to Earth can be estimated from coronagraphy and heliographic imaging, there is currently no reliable remote-sensing method to measure Bz in advance of in-situ measurements at L1 (e.g. by Wind or ACE). However, it has been suggested to use the interaction of charged, micron-sized interplanetary dust particles with a CME to derive its magnetic field structure (Ragot & Kahler 2003).

We will present first results from dynamical models that simulate the interaction of an idealized CME with the ambient dust enviroment of the F corona. Radiative transfer models are used to generated synthetic maps of the scattered-light intensity. We will discuss the suitability of the method for space weather forecasting and lay out planned improvements of our modelling techniques.

The method could contribute to the development of an advanced space weather warning system in the framework of the EU FP7 Space Research project "Advanced Forecast For Ensuring Comminucations Through Space" (AFFECTS). We will argue that the measurements should best be done from one of the Lagrangian points L4 or L5, thereby strengthening the case for a constellation of space-weather spacecraft at sub-L1, L4 and L5.

Forecasting the High Energy Electron Radiation Belts within the FP7 SPACECAST Project

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Solar activity can trigger sporadic bursts of energetic particles in the solar wind and increase the number of high energy (MeV) particles trapped inside the Earth's radiation belts. These high energy particles cause damage to satellites and are a hazard for manned spaceflight and aviation. Here we focus on the high energy electrons. We describe the first European system to forecast the high energy electron radiation belts which has been developed as part of the EU FP7 SPACECAST project. The system is unique in that it uses physics based models and provides a forecast for the whole radiation belts including medium Earth orbit and geostationary orbit. We briefly describe how data on geomagnetic indices and solar wind parameters are collected in near real time to a database operated by DH Consultancy in Belgium, processed, and then accessed by modelling centres in the UK and France. These data are used to drive independent computer models to forecast the high energy electron flux throughout the outer radiation belt for up to 3 hours ahead. The results are subsequently collected, post-processed and displayed on the SPACECAST web site (http://fp7-spacecast.eu/). We present model forecasts of the >800 keV integral electron flux during the 7-8 March 2012 geomagnetic storm which compare reasonably well with observations at geostationary orbit by the GOES satellite. During this magnetic storm there was also a large solar energetic particle event which prevented the ACE satellite from measuring the solar wind velocity correctly, and which contaminated the GOES >2 MeV electron flux. We show that by using a nowcast of the Kp index provided by the British Geological Survey we were able to continue forecasting the radiation belt electron flux throughout the storm successfully. The event illustrates that the SPACECAST forecasting system is robust. We also show that by extending the outer boundary of the model from L* = 6 to L* = 8, and by including wave-particle interactions in the outer magnetosphere, the electron forecasts are significantly improved. We present skill scores to quantify this improvement, and discuss how the data can be presented in the form of the 24 hour electron fluence >2 MeV for use by satellite operators.

New tools to relate Imagery with in-situ Data and their Application to space-weather Forecasting:

Rouillard, Alexis[1]; Lavraud, Benoit[1]; Pitout, Frederic[1]; Genot, Vincent[2]; team, CDPP[2]; Dusan, Odstrcil[3]
[1]IRAP; [2]IRAP/CDPP; [3]GMU/GSFC

The physical mechanisms responsible for heating the solar wind, for accelerating solar particles to high energies or for the injection and transfer of energy to and within the magnetosphere-ionosphere system are still largely debated. These gaps in theoretical understanding combined with the complexity of modeling space plasmas, force heliospheric space-weather forecasters to rely on simple empirical relations to specify boundary conditions such as: -the speed of the solar wind near the Sun or -the injection spectra of high-energy particles. IRAP and its associated data center CDPP are heavily involved in providing the data and tools necessary to analyze and relate the various space plasma data necessary to test our theoretical understanding of energy and momentum transfers. We will present how these new tools facilitate comparisons of solar imagery with in-situ measurements, why they are useful to analyze the data taken by current missions (STEREO, SDO, ACE, Wind, etcâ€¦), how they will be adapted to future missions (Solar Orbiter) and Solar Probe +. We will also present how these tools are useful for calibrating the inputs of the background solar wind used by current 3-D MHD modeling of the solar wind.

NASA GSFC Space Weather Center - Innovative Space Weather Dissemination: web-Interfaces, mobile Applications, and more.

Maddox, Marlo[1]; Zheng, Yihua[1]; Rastaetter, Lutz[2]; Taktakishvili, A.[2]; Mays, M.L.[2]; Kuznetsova, M.[2]; Lee, Hyesook[3]; Chulaki, Anna[2]; Hesse, Michael[2]; Mullinix, Richard[2]; Berrios, David[2]; Pulkkinen, Antti[4]
[1]NASA Goddard Space Flight Center; [2]NASA/GSFC; [3]NASA/GSFC and KMA; [4]NASA/GSFC and CUA

The NASA GSFC Space Weather Center (http://swc.gsfc.nasa.gov) is committed to providing forecasts, alerts, research, and educational support to address NASA's space weather needs - in addition to the needs of the general space weather community. We provide a host of services including spacecraft anomaly resolution, historical impact analysis, real-time monitoring and forecasting, custom space weather alerts and products, weekly summaries and reports, and most recently - video casts.

There are many challenges in providing accurate descriptions of past, present, and expected space weather events - and the Space Weather Center at NASA GSFC employs several innovative solutions to provide access to a comprehensive collection of both observational data, as well as space weather model/simulation data. We'll describe the challenges we've faced with managing hundreds of data streams, running models in real-time, data storage, and data dissemination. We'll also highlight several systems and tools that are utilized by the Space Weather Center in our daily operations, all of which are available to the general community as well. These systems and services include a web-based application called the Integrated Space Weather Analysis System (iSWA http://iswa.gsfc.nasa.gov), two mobile space weather applications for both IOS and Android devices, an external API for web-service style access to data, google earth compatible data products, and a downloadable client-based visualization tool.

Status of the Kjell Henriksen Observatory (KHO) auroral forecast Service

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A method to forecast, up to one hour in the future, the location of the aurora is described. The work is based on mathematical descriptions of the aurora ovals coupled to predicted values of the planetary Kp index. As a result, the ovals are mapped in position and time onto a solar illuminated surface model of the Earth. It displays both

the night- and dayside together with the location of the twilight zone as Earth rotates under the ovals. The graphical display serves as a tool to forecast auroral activity, even to mobile phones. Status and further plans for the service will be presented.

Real-time scintillation Monitoring at high-Latitudes

Schäfer, Sebastian; Jacobsen, Knut Stanley
Norwegian Mapping Authority

The most threatening space weather effect for modern satellite based navigation and positioning systems is ionospheric scintillation, which is particularly complex at high latitudes. In order to evaluate the establishment of a reliable real-time monitoring of scintillation in this region, the Norwegian Mapping Authority (NMA) and the Centre National d'Etudes Spatiales (CNES) operate three Septentrio PolaRxS receivers at latitudes between 65°N and 80°N.

The scintillation receivers are located on Vega, in Tromso and in Ny-Alesund and are used to process signals from both GPS and GLONASS satellites with a sampling rate of up to 100Hz. Algorithms have been developed in order to determine the scintillation indices S4 and óoe in real-time with an update rate of one minute. The receivers ensure a robust detection of scintillation at high latitudes also during intense ionospheric disturbances.

We will present the first results of the real-time scintillation monitor. The observed ionospheric response will be discussed for selected time periods of strong solar activity recorded in 2012. Both time series and maps will be provided showing the temporal development and the spatial distribution of the occurrence of scintillation at high-latitudes. The resulting scintillation indices will be compared with the observed ROTI values (Rate-Of-TEC-Index) at the corresponding locations, which are obtained from the NMA Real-Time Ionospheric Monitor (RTIM). In addition, overview maps have been developed that collect the information about the scintillation activity over the last 10 minutes. The maps consists of a simple three-step colour code indicating low, medium and strong scintillation and, currently, have a spatial resolution of 5x5 degree in longitude and latitude. These maps are intended for users, for example in avionic and maritime navigation industry, who are interested in a quick and reliable information about the location of ionospheric scintillation at high latitudes.

The Space Weather Hazard to the UK Electricity Transmission System: A 2012 Update

Thomson, Alan W P; Beggan, Ciaran D; Beamish, David; Kelly, Gemma S
British Geological Survey

The UK high voltage transmission system is a complex network of more than 600 substation nodes and 1200 interconnecting lines, operating at 400 kV and 275 kV and connected to the lower voltage distribution system at 132kV and below. Modelling and understanding the flow of geomagnetically induced currents (GIC) in this network, caused by space weather, has previously been considered, for example by Beamish et al , 2002 and Thomson et al, 2005. These earlier papers made some simplifying assumptions about both the grid topology and the conductivity of Earth beneath the UK, as well as the conductivity of the surrounding seas and Atlantic Ocean. A representative picture of the geographical distribution of GIC 'hotspots' was deduced, in general agreement with results published on other national power networks; that is with larger GIC typically found towards coastal and physically remote sites.

Since 2010, a number of major developments have increased the detail represented within both the UK grid and conductivity models. These developments are partly a result of concerns at government level about the exposure of the UK grid to space weather, prompting studies of potential worst case scenarios for the UK system. In collaboration with the grid transmission operator, National Grid UK plc, we have therefore investigated the impact on individual transformers within the grid. At the same time, as part of the 'European Risk from GIC' (EURISGIC) EU-FP7 project, we have been developing an understanding of the response of the UK grid to space weather, in the wider European context, for hypothetical and historical events.

In this poster we review the major changes made to the BGS model of the UK's high voltage power transmission system, and to the model of UK conductivity from which we calculate the surface geo-electric field that drives GIC in the power system. We present results from these models for suggested worst case scenarios, where the rate-of-change of the horizontal magnetic field reaches 5000nT/min (compared with around 650 nT/min at the peak of the October 2003 'Halloween' geomagnetic storm). We compare these results with earlier models and, if space allows, compare also with results from the pan-European EURISGIC model, which contains a simplified representation of the UK grid. Our results show, for example, the impact on the likely distribution of GIC in the UK from adding the 132kV distribution network. These results suggest that lower voltage networks, which are generally of higher electrical resistance, may not be discounted in the modelling of some power systems.

Interpolation and Cassification of geomagnetic Variations using neural Network Techniques

Wik, Magnus[1]; Wintoft, Peter[2]
[1]NeuroSpace; [2]Swedish Institute of Space Physics

Modelling of geomagnetically induced currents (GIC) often requires interpolated geomagnetic field in a grid covering the power grid. The risk associated with GIC depends on the type of disturbances, geomagnetic latitude and local time. In this study, still under development under the EU/FP7 project EURISGIC, we present some preliminary results.

There already exist physics-based interpolation techniques of the geomagnetic field, but in this study we use an empirical method, based on neural networks, and a priori knowledge of the inherent property of vector fields. The inputs consists of archived geomagnetic data from magnetometer stations around Europe. The outputs from the model consist of interpolated geomagnetic vector fields in a dense grid. A comparison is also made with other techniques.

In the same study, we have used pattern classification of geomagnetic time series, for a list of geomagnetic storm events, using recurrent neural networks and self organising maps, to determine and analyse different physical processes as a function of location and time. Both methods could hopefully be used to better model GIC and classify geomagnetic disturbances.

Space weather at Mars: a major Driver for its Climate?

Leblanc, Francois
LATMOS

Mars' climate has changed significantly since 4.5 Gyr ago. Many geological, minearological and atmospheric observations suggest that Mars should have hosted, during parts of its history, a much denser and wet atmosphere that at present. During the early age of the solar system, Mars had probably a bar size atmosphere, with a water reservoir equivalent to a 100 m water size ocean covering the whole surface, with an intrinsic dynamo probably strong enough to protect the atmosphere from any direct interaction with the solar wind and an active volcanism. Today, Mars has a mbar size atmosphere, a water reservoir of only few micro-meters, only a remanent crustal magnetic field that does not contribute significantly to Mars' interaction with the solar wind and a few Gyr old surface. What has been the fate of Mars' atmosphere and its past climate are therefore one of the main outstanding question regarding Mars. Mars' atmosphere could have escaped into the space, a possibility that will be the main objective of a US mission, MAVEN, that will be launched in 2013. Mars' atmosphere could have been also reabsorbed into the Martian crust, a possibility which was and is the subject of many Mars past and future missions including Mars Science laboratory to be launched in 2012. The role of the space weather at Mars is therefore the subject of many observations and theoretical works. In this presentation, I will summarize our present understanding of Mars' evolution, of the possible role of the Sun and how space weather at Mars is integrated in our model of Mars' past evolution.

The Response of the Troposphere and Surface to the 11-yr solar cycle Variability in idealized ensemble Simulations

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The possible influence of the 11-yr solar cycle on the coupled atmosphere-ocean system of the tropical Pacific has drawn considerable attention in the recent years. Analyses of observations and historical reconstructions detected either an El Niño-like warming or a La Niña-like cooling in solar maxima. To examine the response of the troposphere and surface to the 11-yr solar cycle we conduct idealized ensemble simulations with the middle atmosphere version of ECHAM5 coupled to two types of ocean models: a mixed layer and a full-coupled dynamical model. To ease explanations, a sinusoidal solar cycle of realistic amplitude is assumed. Our simulations do not support the notion of a La Niña excitation in solar maxima. Instead, we find that the tropical Pacific warms in solar maxima both in the mixed layer and the full-coupled ensembles, with stronger warming in the former ensemble. The tropical Pacific hydrology changes accordingly. Although the tropical upper atmosphere responds immediately to the solar forcing, the tropospheric response lags by 1 to 2 years, in rhyme with the surface response. We further discuss mechanisms whereby the simulated warming over the tropical Pacific may affect remote regions as the North Atlantic Ocean and Europe. There, the full-coupled ensemble successfully captures the solar cycle signals detected on proxy-based surface temperature reconstructions.

Cosmic Ray induced aerosol Formation in Earth's aAmosphere

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Danish Technical University

Cosmic rays penetrating Earth's atmosphere produces ions which can enhance nucleation as shown by theory, observations, and experiments, but the exact mechanism still remains to be determined. In particular nucleation of the dipolar sulfuric acid - water system has been investigated since ion-induced nucleation is expected to increase the nucleation rate at the critical cluster size, where the charge makes the small clusters more thermodynamically stable than their neutral counterparts and thus reduces the energy barrier to nucleation.

Also the initial growth rates of small ion clusters are found to be enhanced by the dipole-charge interaction between the core ion and the strongly dipolar condensing sulfuric acid and/or water molecules. In the initial phase these ion-molecule interactions greatly accelerate the kinetics of molecular association. During the later stages of aerosol growth (from 2-3 nm and larger) the effect of the ion is expected to become small and the growth rate will be dominated by the vapor pressure of the condensing species.

We have studied ion-induced nucleation of the sulfuric acid - water system under a variety of conditions from an ultra-low background radiation environment 1100 meter underground to ionization densities far above the natural levels found in the atmosphere using a particle accelerator. Together with recent advances in modeling this has increased our understanding of the nucleation mechanism and the role of ions.

Testing a Link between cosmic Rays and Cloudiness over daily Timescales

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Much debate still remains regarding a hypothesized link between the solar-modulated cosmic ray (CR) flux and the Earth's cloud properties influencing the climate. Recently, it was shown that numerous long-term studies of satellite-based cloud observations are limited by non-trivial disadvantages, such as: satellite data intercalibration issues, view-angle biases, and the influences of factors on cloud cover like ENSO and volcanic eruptions interfering with the analyses. Consequently, the reported studies have failed to present compelling evidence of a CR-cloud link. The satellite-data limitations can be resolved by focusing on short-term (daily) timescales using Forbush decrease events and epoch-superpositional (composite) methods. Unfortunately, these studies have also arrived at a range of conflicting conclusions. It may be the case, that for the short-timescale studies, a hypothesized CR induced signal in clouds may be drowned in the meteorological noise, and noise may even be mixed with the (likely far smaller) hypothesized signal. Using extensive Monte Carlo simulation techniques and two most widely used satellite cloud datasets (ISCCP and MODIS), we quantitatively demonstrate how the high noise levels present in composites of small sample sizes, or for overly isolated sample areas, may predominately account for the inconsistent results obtained. Furthermore, we find that assumptions made by classical statistical tests (like the Student's T-test) are frequently violated by both the restricted samples and methods frequently employed in the literature (such as normalization to an averaging period). We conclude that such tests should be avoided, in favor of MC simulations, which offer a far more robust method of assessing significance and enabled us to correctly assess the significance of some recent short-term studies purporting to identify evidence of a CR-cloud link.

Response of the fair weather electrical Current to geomagnetic Substorms at a desert Station in southern Israel

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[1]The open Unviersity of Israel; [2]Tel-Aviv Uniersity

The global electrical circuit (GEC) postulates a constant downward flowing conductance current (Jz) equal to ~2 pA m-2 (Williams, 2009). Continued measurements of the vertical fair-weather atmospheric electrical current have been carried out from May 2011 continuously at Tel-Aviv University's Wise astronomical observatory in the Negev desert, Israel (30° 35' 45" N, 34° 45iä 48" E, altitude 875m above sea level). The instrument we used is a modified version of the GDACCS design described by Bennet and Harrison (2008) which is capable of measuring the fair-weather current density with an accuracy of 0.4 pA m-2. The sensors are placed on a flat 1.5m x 1.5m concrete surface 150m away from the observatory. The signal is passed in a differential mode to the computer at the observatory, sampled at 250Hz by the data acquisition program (LabView) and saved to 1 minute files with a GPS time stamp every 1 second. In addition to the Jz we collect ELF data in the Schumann Resonance band, and record the vertical component of the electrical field and the NS and EW magnetic field components with an accuracy better than 0.1 pT.

While we easily note a diurnal variation in Jz, dictated by the local meteorological conditions such as wind speed, relative humidity and dust concentrations, there are some clear anomalies which differ from background conditions. We report preliminary indications for a response in Jz to changes in geomagnetic conditions during storms induced by solar flares, as evident from the correlation we find between fluctuations in Jz and the flux of solar protons >10 MeV in solar quiescent and storm conditions. Large values of the variance of the conductance current were observed during 3 different Coronal Mass Ejections, which included solar proton events (SPE) on 26/09/2011, 25/10/2011 and 08/03/2012. We infer this behavior as a response of the global electrical circuit to solar activity leading to enhancement of the ionospheric electric field, as suggested by Belova et al. (2001).

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Solar variability Effects on Climate

Beer, Juerg
Eawag

It is well accepted that the Sun is the engine which drives the climate system. It is also well known that the Sun is variable star. This raises the important question to what extent solar variability causes climate change. This question is still controversially debated. Some people believe that solar forcing is a dominant factor while others claim that its effect on climate is negligible. A final answer is difficult for several reasons. Direct satellite based measurements of the total solar irradiance (TSI) are only available for about 35 years, a period of generally high solar activity. The change of TSI during an 11-y cycle is small (typically 0.1%) and the radiometers show considerably degrading effects which have to be corrected for.
For the past 400 years the best information available is the sunspot number which reflects basically the magnetic activity on the solar surface. Beside the 11-y cycle it shows clear indications of longer cycles (e.g. 87-y Gleissberg cycle) and the existence of grand minima, periods of 50-100 years when almost no sunspots could be observed (e.g. Maunder Minimum).
To extend the record of solar activity much further one has to rely on indirect proxies of solar magnetic activity, so-called cosmogenic radionuclides such as 14C and 10Be. These cosmogenic radionuclides are produced in the atmosphere by cosmic ray particles interacting with the atoms of nitrogen and oxygen. The production rate of cosmogenic radionuclides is modulated by the solar wind which acts as a magnetic shield against cosmic rays. The more active the Sun the lower is the production rate. After production some of these cosmogenic radionuclides become stored in natural archives; 14C in tree rings, 10Be in polar ice sheets. These records allow us to reconstruct the history of solar activity for the past 10,000 years. They tell us a lot about the Sun and its relative long-term behaviour. However, it is very difficult to figure out how much in Watt per square meter TSI has changed in the past. Nevertheless there is growing evidence for solar induced climate change in the past.

Solar Irradiance in cycle 23: Modelling of TSI and SSI by synoptic intensity Observations

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An apparently unusual behaviour of the Total Solar Irradiance (TSI) during the last solar minimum, together with unexpected trends of the spectral irradiance variations measured over the declining phase of the last solar cycle, and the registered failure of some irradiance models to reproduce TSI measurements have been interpreted as new evidences of a fraction of the measured solar irradiance variability unexplained by the evolution of surface magnetism. On the other hand, newest results put the responability of these inconsistencies to calibration problems of both total and spectral irradiance measurements.

We use the synoptic full-disk observations carried out with the PSPT telescopes and results of the spectral synthesis performed on semi-empirical atmospherical models to reconstruct measurements of both TSI and SSI variations from 1997 to 2012. We also investigate the contribution to the measured iirradiance variations of the various solar features resolved on PSPT observations.

What can we learn about the Sun with PREMOS/PICARD?

Shapiro, Alexander; Cessateur, Gaël; Schmutz, Werner; Tagirov, Rinat
PMOD/WRC

The spectral solar irradiance is a key input parameters to atmospheric/oceanic and space weather models. It varies on time scales ranging from minutes to millennia, and its variability is strongly wavelength-dependent. Despite many efforts, a complete picture of the solar irradiance variability is still missing. The data from the recent European mission PICARD with PREMOS package onboard provides therefore valuable information and is able to nourish theoretical models. This instrument covers the solar spectrum from the UV to near-infrared. The PREMOS measurements were carefully corrected for the degradation and cleaned for non-solar signatures. We provide a comparison with the VIRGO/SOHO and SOLSTICE+SIM/SORCE data.

We employ the recently developed and published COde for Solar Irradiance (COSI) to model the solar variability as observed by PREMOS. We discuss different physical mechanisms which are responsible for formation of the solar spectrum at different wavelengths. The comparison between PREMOS measurements and COSI calculations is used to test and constrain the existing models of the solar atmosphere.

The deep Project

Eicker, Norbert
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Cluster computers are dominating high performance computing (HPC) today. Basically, such machines for massively parallel processing (MPP) are set up from commodity building blocks. The success of this architecture is based on the fact that it profits from the improvements provided by mainstream computing well known under the label of Moore's law.

With systems at Petascale (10^15 operations per second) in production today the next goal in HPC is to reach Exascale (10^18 operations per second) by the end of the decade. Obviously, this target introduces new challenges. First of all there are technological problems like energy efficiency or resiliency to be overcome. Furthermore, it is questionable, if general purpose CPUs will still be competitive from an energy efficiency point of view with more specialized solutions like accelerators, namely GPUs. The scalability of today's systems is limited by the way accelerators are employed. Therefore it will become a necessity to review the idea of the cluster architecture in HPC in order to prolong their success into the future.

In order to find possible directions for next generation supercomputers we review Amdahl's and Gustafson's thoughts on scalability. Based on this analysis we propose an advance architecture combining a Cluster with a so called Booster element comprising of accelerators interconnected by a high performance fabric. We argue that this architecture provides significant advantages compared to today's accelerated clusters and might pave the way for clusters into the era of Exascale computing.

The EU-project DEEP is aiming for an implementation of this concept. This includes both, the actual hardware of a Booster system based on Intel's XEON Phi processor-architecture and the EXTOLL high-performance interconnect, and an advanced software-stack required to operate and use the Booster hardware. Besides the actual system-level layers of software the latter includes forward-looking programming paradigms that shall enable application-programmers to express the various levels of scalability embedded in their problems in a straight-forward and maintainable way. It comprehends runtime-environments optimizing the use of the proposed hardware-architecture.

Along this line six applications from fields having the potential to exploit Exascale systems will be ported to DEEP enabling for a co-development in the fields of programming-models and runtime-systems for HPC. We analyze one application from the field of space-weather in detail and explore the consequences of the constraints of the DEEP systems on its scalability.

Increasing the domain Size of kinetic Simulations: a multi level multi domain Method for Plasma Simulations

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The simulation of large portions of the heliosphere (e.g., the magnetosphere) with a kinetic description is still an unattainable goal both with the current petascale computing and with the upcoming exascale computing. This has two causes: not only the wide gap in orders of magnitude between the spatial scales of interest in the system and the size of the system itself, but also the stability constraints of kinetic methods, which impose to resolve spatial scales smaller than the scales of interest for purely numerical reasons, thus increasing the computational requirements of the simulation. This second aspect can be made less critical with a little shrewdness. Implicit algorithms can be used instead of explicit ones to relax the stability constraints, thus allowing to use bigger grid spacings. Instead of simulating the entire system with the same grid spacing, different parts of the domain may be simulated with different resolutions chosen in order to resolve the local scales of interest rather than the smallest one in the entire system. The Multi Level Multi Domain (MLMD) method we present here has been designed following the above mentioned lines. The full domain is simulated as a collection of an arbitrary number of levels simulated fully in fields and particles with increasing grid resolution. This way, the expensive high resolutions are used only when needed, rather than imposing a very small grid spacing also in portions of the grid where it is not required by the physics of interest. Moreover, an implicit moment method (IMM) is used to advance fields and particles on each level to substitute the strict stability constraints of explicit methods with the less strict accuracy constraint of the IMM. Such a choice also grants increased freedom in choosing the refinement factor (RF) to be used between the levels also when the time spacing is kept fixed in the system.

In this work, the major differences between MLMD and Adaptive Mesh Refinement (AMR) algorithms, mostly concerning the treatment of particles at the refinement levels, will be addressed. Communication and interlocking operations between the grids (boundary condition interpolation from the coarse to the refined grids, field projection form the refined to the coarse grids and particle repopulation at the boundary of the refined grids) will be explained in details and, finally, test simulations exploring the field and particle structures evolution across the interlocked grids in 1D and 2D will be presented, together with performance considerations.

A 3D Global Magnetohydrodynamic Simulation of the Solar Wind/Earth's Magnetosphere Interaction

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KU Leuven

We present results of a 3D global magnetohydrodynamic simulation of the solar wind interaction with the Earth's magnetosphere driven by the time-varying NASA Advanced Composition Explorer (ACE) satellite data during the April 6th, 2000 event. It is shown that the upstream solar wind plasma parameters enter the low-beta switch-on regime for several instants during a magnetic storm causing a complex dimpled bow shock structure. We also investigate the trace of such bow shock structures in the steady state results for certain parameter values during the event, when the solar wind plasma is in the low-beta switch-on regime, as well as during time-dependent simulations of the event. We utilize a 3D, implicit, parallel, unstructured grid, compressible finite volume ideal MHD solver for our simulations. This solver is implemented inside COOLFluiD, which is an object-oriented multi-physics framework into which we plan to implement different space weather models and couple them with the abovementioned global magnetohydrodynamic model in the future.

Coupled Magnetosphere - Ionosphere - Thermosphere - Ring Current Modeling with the OpenGGCM

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The Open Geospace General Circulation Model (OpenGGCM) is a coupled model of the outer magnetosphere, the magnetosphere - ionosphere (MI) coupling region, the inner magnetosphere and the ring current, the ionosphere, and the thermosphere. The outer magnetosphere part solves the time-dependent MHD equations or Hall-MHD equations. The inner magnetosphere sub model is either the Rice Convection Model (RCM) or the Comprehensive Ring Current Model (CRCM). MI coupling is primarily based on empirical models that compute electron precipitation parameters. The latter, along with the ionosphere potential, are fed into the Coupled Thermosphere Ionosphere Model (CTIM), which is by itself a fully dynamical 3d model of thermospheric and ionospheric species and their interactions. CTIM in turn provides conductance and dynamo currents back to the ionosphere potential solver.

The OpenGGCM has been in development for some 20y and has been used for numerous studies. We shall present examples relevant to space weather, such as neutral upwelling events relevant to satellite drag, ground magnetic perturbations relevant to ground induced currents, and event studies of substorms and storms. We will also discuss some recent developments, such as the use of advanced computer architectures, Hall-MHD, and data assimilation via an Ensemble Kalman Filter.

Coupling at the Earth in SWIFF: Ionosphere-plasmasphere-polar Wind-Radiation Belts

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Belgian Institute for Space Aeronomy

SWIFF (Space Weather Integrated Forecasting Framework) is a FP7 project that has for objective to develop an integrated framework for the physics modelling of space weather from the solar corona to the Earth.

Concerning the coupling at the Earth, a 3D dynamic model of the plasmasphere has been developed and coupled to the ionospheric IRI model. The three dimensional coupled model determines at any chosen time the number density and the temperatures of the electrons and ions for altitudes from 60 km to the position of the plasmapause and even at higher radial distances in the plasmaspheric trough. The plasmapause position is highly variable depending on the geomagnetic activity.

The polar wind is also modeled with a similar kinetic approach as used for the plasmasphere, but considering open magnetic field lines at high latitudes. The model determines the profiles of all the moments of the particles, and especially density, temperatures, escape flux and heat flux.

Finally, the outer electron belt is highly variable with space weather. During geomagnetic storms, the electron fluxes vary from several orders of magnitudes and the outer belt penetrates closer to the Earth. Links between the dynamics of the radiation belts and the position of the plasmapause have been identified with satellite observations.

The links between these different regions of the inner magnetosphere and the principles of the different dynamic models based on the kinetic approach that are developed at BISA will be described. The results of these models are made available to the scientific community by free run on the space weather portal (www.spaceweather.eu).

Test particle Simulations of Solar Energetic Particle Propagation for Space Weather

Marsh, Mike; Dalla, Silvia; Kelly, James; Laitinen, Timo
University of Central Lancashire

A crucial objective of space weather modelling is forecasting the arrival of Solar Energetic Particles (SEPs) and their intensities at a given location in space. The FP7 COMESEP (Coronal Mass Ejections and Solar Energetic Particles: Forecasting the Space Weather Impact) project includes modelling of both SEP and CME propagation. The SEP propagation model is a full-orbit test particle numerical code that allows transport across the mean magnetic field to be taken into account and flexibility in the definition of the large-scale interplanetary magnetic field configuration. Time dependent injection functions are studied to simulate particle acceleration due to a CME shock front and the resulting SEP intensities measured e.g. near Earth investigated. Within COMESEP, the objective is to link the detection and propagation modelling of CMEs with the SEP model, where information about the CME's characteristics is an input to the test particle simulations. We present initial results from this modelling effort. This work has received funding from the European Commission FP7 Project COMESEP (263252).

Coupled global Modeling of SEP Acceleration in a coronal CME/Shock and subsequent interplanetary Transport to 1 AU

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A growing body of theoretical and observational evidence suggests that solar energetic particles may gain most of their energy at traveling shocks relatively close to the Sun. The observed and modeled Alfven speed profiles in the corona allow for fast shocks to easily develop within 20 solar radii. By coupling global MHD simulation results for a case study coronal mass ejection and related shock with a global energetic particle acceleration and transport kinetic model, we investigate SEP acceleration in the three dimensional corona. We show that the shock and various plasma structures may efficiently accelerate suprathermal protons to hundreds of MeV energies during their coronal transit. The resulting SEP flux spectra vary greatly depending on the latitudes and longitudes of the guiding field lines. We follow the proton fluxes to 1 AU and determine their longitudinal dependence. This result may confirm shocks as the dominant mechanism for creation of energetic particles in the vicinity of the Sun, and help explain the variation in observed SEP time series at 1 AU.

Solar energetic particle Simulations in SEPServer - How to deal with scale Separation of thirteen Orders of Magnitude

Vainio, Rami[1]; Afanasiev, Alexander[1]; Agueda, Neus[2]; Battarbee, Markus[3]; Ganse, Urs[4]; Kilian, Patrick[4]; Pomoell, Jens[1]; Sanahuja, Blai[2]; Spanier, Felix[4]; Valtonen, Eino[3]
[1]University of Helsinki; [2]University of Barcelona; [3]University of Turku; [4]University of Würzburg

The EU/FP7 project SEPServer will develop simulation tools for modeling the acceleration and transport of solar energetic particles (SEPs), i.e., ions and electrons accelerated to high energies in solar flares and coronal mass ejections (CMEs). Global modeling of SEP events - including their acceleration in coronal shocks and reconnecting current sheets and their transport to the observer - involves a huge variety of scales ranging from electron scales in the coronal plasma (~1 cm) to the global system size (~1 AU). Thus, multiple plasma simulations are needed to tackle the problem.

In this presentation, we describe the set of simulation tools that are being developed, to understand the acceleration and transport of SEPs in a coherent manner. We discuss the requirements for integration of these tools into coupled simulation models. Our toolbox consists of an MHD simulation describing the global evolution of the bulk plasma during the solar eruption, Monte Carlo simulation tools for the acceleration and transport of electrons and ions, a turbulence transport code describing the evolution of high-frequency MHD fluctuations in the solar wind, and a PiC code describing the fine structure of shocks and current sheets as well as the acceleration of electrons in these environments. We will present case studies where the models are used in concert to obtain a description of SEP acceleration and transport during a solar eruption.

Satellite Orbits and ATMOP: improving thermospheric density Modelling through Data Assimilation

Henley, Edmund
Met Office

The Atmop project (www.atmop.eu) aims to improve predictions of how space weather affects the trajectories of low-orbiting satellites, via changes to the thermospheric density, which alter the drag on the satellites.
These improved predictions will mainly be provided by an advanced semi-empirical model, as well as creating better proxies for the solar and geomagnetic drivers of the thermosphere-ionosphere system.

However, in order to go beyond the statistical modelling of thermospheric density, and allow better representation of particular or rarely-seen conditions, Atmop also involves work on a physical model of the thermosphere-ionosphere system.

One component of the physical model work is data assimilation - bringing model output closer to reality by regularly incorporating observations, much as realistic weather forecasts are obtained by regularly assimilating observational data into general circulation models of Earth's lower atmosphere.
An important part of data assimilation is controlling the quality of the observational data to be incorporated - ensuring the data is physically reasonable, and that it will not cause problems for the model.

This presentation will present Atmop work on observational quality control in the context of a physical model of the thermosphere-ionosphere system, and discuss the design of the data assimilation scheme.

Overview of space weather impacts on satellites

Ryden, Keith
QineTiq Fellow, UNITED KINGDOM

Ourreliance on space infrastructure is growing and its potential vulnerability to space weather is becoming a cause of concern at high levels in government and elsewhere (for example with space insurers), especially in the context of extreme storm events such as the Carrington Event of 1859. However previous experience of space weather does not necessarily lead to us to 'Armageddon' scenarios for the global fleet of satellites, not least because of the careful engineering adopted in space projects. On the other hand it is clear that over the years many satellites have suffered space weather-induced anomalies, outages and failures often due to apparently quite minor storm events. In this talk, we will provide an overview of the historical experience of space weather iin practical terms, the engineering reasons for problems and failures, the complex interplay with commercial and security interests. We aim to set out some of the key challenges for the future.

The Space Environment - A satellite manufacturer's perspective

Tye, Daniel
Surrey Satellite Technology Limited (SSTL)

The Space Environment Team at SSTL is responsible for the thermal control and for the radiation assurance of the satellite. Here, the effects of the radiation environment in Space is discussed, along with the mitigation strategies that SSTL employs to ensure the risk posed by radiation is managed to a level commensurate to the many other risks involved in spaceflight.

SSTL is well-known for employing Commercial Off The Shelf (COTS) electronic components in their satellite products. This approach significantly reduces cost and enhances satellite capability, but exposes components to a radiation environment for which they were not designed.
Presented here is an insight into the thought processes, research, testing, and design rules that have enabled SSTL to follow this approach for more than 30 years and 36 satellites - without the premature loss of a satellite through radiation damage.

This is backed up by in-orbit data from equipments and some of the many radiation monitors SSTL is flying that show the effects of radiation events on our subsystems and demonstrate the robustness of this approach through changing circumstances.

We will also show some case studies and mission highlights.

Commercial Development of MEO: An Insurance Perspective

Wade, David
Atrium Insurance

Medium Earth Orbit (MEO) has primarily been the preserve of military satellites to date but this will change over the next couple of years as new commercial satellite projects start to occupy this region. In 2013 the O3b constellation will be launched. Operating from a orbit of 9000 km, the O3b satellites will be the first commercial satellites to orbit in the slot region. By 2015, it is expected that the first all-electric geosynchronous communication satellite (the Boeing 702SP) will be launched. Whilst the final destination of such satellites will be geosynchronous orbit, the use of electric propulsion for orbit-raising in addition to station-keeping will expose the satellite to the MEO environment for months as opposed to a conventional geosynchronous satellite which would typically complete orbit raising within a few days. Clear commercial advantages exist for all-electric satellites so manufacturers other than Boeing are also expected to propose all-electric satellites as part of their product range in the coming months.

This presentation will provide an overview of developments in the commercial satellite sector that involve the greater use of MEO, consider previous commercial MEO experience and the implications that the prolonged exposure to the MEO environment may have on satellite design. The presentation will finish with an insurers perspective of these developments and an overview of factors that may affect the insurance assessment of such risks.

Calculation of the Satellite Surface Charging using forecasted low energy Electron Fluxes

Ganushkina, Natalia; Amariutei, Olga
Finnish Meterological Institute

Modern society depends on a variety of technologies that are susceptible to severe disturbances of the ionosphere and of the near-space environment that are driven by the activity of the Sun. Space weather can adversely affect a wide variety of systems including the space assets such as satellites, manned and unmanned space vehicles and launch vehicles with the addition, although not strictly space assets, of high altitude aviation flights. This study proposes a methodology of forecasting low energy electron population for the study of the effects of the surface charging on spacecraft. We use Inner Magnetosphere Particle Transport and Acceleration Model (IMPTAM), developed by Ganushkina et al. [2001, 2005, 2006], which is a tool to model and forecast the behavior of ring current and radiation belts particles in the inner Earth's magnetosphere.

NASA GSFC Space Weather Center operational Experiences over the past several major solar Events

Zheng, Yihua[1]; Pulkkinen, A.[2]; Taktakishvili, A.[3]; Mays, M. L.[4]; Lee, H.[5]; Chulaki, A.[6]; Kuznetsova, M. M.[4]; Hesse, M.[4]
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As a sibling organization of the Community Coordinated Modeling Center (CCMC), the NASA GSFC Space Weather Center has been operational since March 2010 (http://swc.gsfc.nasa.gov).

By combining forefront space weather science and models, employing an innovative and configurable dissemination system (iSWA.gsfc.nasa.gov), taking advantage of scientific expertise -- both in-house and from the broader community -- as well as fostering and actively participating in multilateral collaborations both nationally and internationally, NASA/GSFC space weather Center is poised to address NASA's space weather needs (and needs of various partners) and to help enhancing space weather forecasting capabilities collaboratively. With a large number of state-of-the-art physics-based models running in real-time covering the whole space weather domain, it offers predictive capabilities and a comprehensive view of space weather events throughout the solar system. In this presentation, we will share our operational experience over the past several major space weather events and how they affected NASA spacecraft throughout the solar system.

Variability of Trapped and Transient Radiation Environment on Highly Elliptical high inclination (Molniya) Orbit

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Our particular interest in analysis of the radiation environment on Molniya orbit has been motivated by the planned Canadian operational communication and weather space mission which would also include operational particle detectors. Because the meteorological payload would have to sustain such a diverse radiation environment, its detailed statistical analysis based on data will give better representation of in-flight conditions than widely used AE-8, AP-8 models. These models do not always adequately represent environment on Molniya orbit, while improved models, such as AE9/AP9, are not available for users yet. Here we present results of statistical analysis of dose rate variability on Molniya orbit, based on HEO-3 data, which includes inner-slot-outer radiation belt regions as well as open field lines affected by transient events (solar energetic particles). To explain the possible source of variability, the behaviour of particular energetic particles (protons and electrons) was also analysed when needed.

Space Weather in the solar System

Coates, Andrew
University College London

Our Sun drives the interplanetary environment and its interactions with the objects within. The gusty, magnetized solar wind provides the upstream environment for all planetary interactions. Naturally we know most about the Earth's interaction, with the solar wind important upstream driving reconnection at the magnetopause and in the tail, and the ionosphere as the inner region as a source of particles. The interaction of other objects depends on their nature - from unmagnetized Venus, Mars and the Moon with small-scale crustal fields, with some similarities to comet interactions, small, magnetized Mercury and the giant, rapidly rotating magnetospheres of Saturn and Jupiter enveloping mainly icy moons, especially Titan and Enceladus at Saturn, and Ganymede, Io, Europa and Callisto at Jupiter. Here we take a tour of the planetary and moon interactions, concentrating on 'space weather' effects.

Plasma Interactions with Ganymede, Europa, Callisto and Jupiter: the Prospects for ESA's JUICE Mission

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The proposed JUICE (JUpiter ICy moons Explorer) mission will provide the first detailed exploration of Ganymede during its orbital mission, and will also study the plasma interaction with Europa and Callisto, as well as exploring Jupiter's equatorial and mid-latitude magnetosphere, affording enhanced views of Jupiter's polar regions. In this paper we will give a brief summary of the mission, and will discuss the plasma-related objectives in plasma-moon interactions and Jupiter's magnetosphere as summarised below.

Related to plasma-moon interactions, JUICE will: (i) Investigate Ganymede's internal, induced, and magnetospheric field components, and how they are modulated by the Jovian magnetosphere, (ii) Identify the magnetic field and particle populations near the moons and their interaction with Jupiter's magnetosphere, including the moon footprint aurora in Jupiter's atmosphere, (iii) Study the particle interaction with the surface of Ganymede, (iv) Contribute to our understanding of the atmospheres of the icy satellites, their origin and evolution Related to Jupiter's magnetosphere, JUICE will: (i) Investigate the global configuration and dynamics of Jupiter's magnetodisc, (ii) Study the electrodynamic coupling between Jupiter's magnetosphere and the satellites, (iii) Assess the global and local acceleration of particles within the giant magnetosphere and (iv) Investigate the magnetospheric region between the orbits of Ganymede and Europa

Physics-based Modeling of the Variations of the solar EUV Spectrum

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Solar spectral irradiance variations in the UV/EUV are important for the detailed modeling of the Earth's upper atmosphere. For the past decades very valuable data are available, however they lack a full temporal and spatial coverage, which is important for investigating and monitoring its effect on the Earth's atmosphere. Therefore, the need of robust and reliable models to reconstruct the irradiance for the full temporal and spectral range is very important. Here, we present the reconstruction of the EUV for specific time intervals for validation. These intervals will then be extended to the full Solar Cycle 23. First, we employ the decomposition of images taken with the Precision Solar Photometric Telescope (PSPT) and SOHO/EIT, deriving the area coverage of brightness features from the chromosphere to the corona. Second, synthetic spectra are calculated for each component for different positions on the solar disk and weighted by their area coverage. This leads to a time-dependent EUV spectrum which is compared with available observations.

Solar energetic Particles and associated Phenomena in Radio and EUV Wavelengths

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The work presents the results of a statistical study on solar energetic particles (SEPs) during solar cycle 23. Among the data sample, 2/3 is associated with flares (of X and M-class) and coronal mass ejections coming from western heliolongitues and 1/3 originated from the eastern hemisphere. We carry out a comprehensive analysis on the link between SEPs and their parent solar activity, by studying the electromagnetic signatures of flares and coronal mass ejections in the corona and IP space. We revisit the topic of predicting SEPs at 1 AU by observations of solar radio emission and focus on the appearance and timing of metric-to-decametric radio bursts with respect to the SEP onset time and profile. Additionally, we include in the analysis the association rate of SEPs with large-scale coronal EUV-disturbances. We discuss the possible application of radio and EUV coronal signatures to the SEP forecasting methods.

The Origins and heliospheric Evolution of CMEs on 7 and 14 August 2010 originating from the same solar source Region

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The relative locations of the STEREO, SOHO, SDO and Venus Express spacecraft in August 2010 provide an opportunity for unique multi-spacecraft observations of two CMEs originating from the same solar source region. On 7 August 2010, a halo CME originating from NOAA AR11093 is observed remotely by STEREO B. Seven days later this active region erupts again, and a halo CME is observed remotely by STEREO A on 14 August 2010.

We show that both eruptions are associated with reverse S-shaped flux rope structures and display a number of typical large-scale features relating to CMEs, including coronal dimmings and EUV waves. By combining remote sensing and in situ observations of the ejecta, we consider the structure and heliospheric evolution of these CMEs and their interplanetary counterparts.

Our estimate of the dimensionless expansion rate of the 14 August 2010 magnetic cloud suggests that this structure may be perturbed by a high speed stream, likely to originate from a coronal hole. Consequently, we address the influence of the surrounding solar wind on the in situ observations of both ICMEs. Additionally, a comparison of the orientations of the axes of the erupting flux ropes near the Sun and in interplanetary space reveals that both CMEs appear to undergo significant rotation as they expand into the heliosphere.

We compare and contrast many aspects of these two eruptions from a remote sensing and in situ perspective, before discussing the evolutionary implications of the similarities and differences between the ejecta.

Dications and thermal Ions in planetary atmospheric Escape

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Because the atmospheric escape is strongly linked to the solar activity, it is an important point of the Planetary Space Weather. Although several mechanisms have proven to contribute, the atmospheric escape remains an open question. The escape of the atmosphere of Mars is

still not fully understood. Its comprehension would give important insights on the other planetary atmospheres. In the recent years, the presence of dications in the atmospheres of Mars, Venus, Earth and Titan has been modeled and assessed. These studies also suggested that these ions could participate to the escape of the planetary atmospheres because a large fraction of them is unstable and highly energetic. When they dissociate, their internal energy is transformed into kinetic energy which may be larger than the escape energy.
The goal of this study is to assess the impact of the doubly-charged ions in the escape of CO2 dominated planetary atmospheres and to compare it to the escape of thermal photo-ions.

We solve a Boltzmann transport equation at daytime taking into account the dissociative states of CO2++ for a simplified single constituent atmosphere of a case-study planet. We compute the escape of fast ions using a Beer-Lambert approach.

We study three test-cases. On a Mars-analog planet in today's conditions, we retrieve the measured electron escape flux. When comparing the two mechanisms (i.e. excluding solar wind effects, sputtering ...), the escape due to the fast ions issuing from the dissociation of dications may account for up to 6% of the total and the escape of thermal ions for the remaining. We show that these two mechanisms cannot explain the escape of the atmosphere since the magnetic field vanished and even contribute only marginally to this loss. We show that with these 2 mechanisms, the atmosphere of a Mars analog planet would empty in another giga years and a half. At Venus orbit, the contribution of the dications in the escape rate is negligible.When simulating the hot Jupiter HD209458b, the two processes cannot explain the measured escape flux of C+
This study shows that the dications may constitute a source of the escape of planetary atmospheres which had not been taken into account until now. This source, although marginal, is not negligible. The influence of the photoionization is of course large, but cannot explain alone the loss of Mars' atmosphere nor the atmospheric escape of HD209458b.

Prediction of ICME Arrival at Mars

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Development of prediction methods for ICME arrival at Mars is important in a space weather context for two main reasons. (1) It will be useful for future Mars exploration, and (2) it may increase our understanding of the structure and heliospheric propagation of ICME's in general, thereby potentially improving our ability to predict ICME arrival at Earth. We use ~6 years of observations from the MAG/ER instrument onboard the Mars Global Surveyor in the previous solar cycle to identify events of significantly enhanced solar wind dynamic pressure and a set of ICME events encountering Mars. We investigate the occurrence pattern of the events relative to the heliospheric current sheet and relative to near Earth observations of ICME's. When the solar source of the ICME's can be identified we employ two existing models of ICME propagation: The global MHD model ENLIL and the drag-based model DBM. These are compared with the observations in order to identify key parameters for a successful prediction. The presented work has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement no 263252 [COMESEP] and no 218816 [SOTERIA].

Comparative planetology Study of extreme solar Events: Mars, Venus, Titan, Earth

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The solar particle events and solar flares impose extreme conditions on the lower thermospheres of planets. As example, the ionization rate in these atmospheric layers can be enhanced by an order of magnitude, leading to the creation of a dominant ion layer at these altitude. The heating also modifies the local structure of the thermosphere. On Earth, the effect is complicated by the presence of the magnetosphere, therefore, it is interesting to compare Earth with objects without magnetospheres, hence Mars, Venus, and Titan when it is outside the magnetosphere of Saturn.

We have modeled the ion and excited species productions in the atmospheres of these bodies with several models, for a solar flare event, and a solar particle event. We computed the resulting effects that can be, or have been, observed in the thermosphere of Mars, Venus, Earth, and Titan.

Advanced methods to model and predict space weather effects - Summary of Progress

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jfwConsult

According to the MoU of the COST Action ES0803 "Developing space weather products and services in Europe", Working Group 1 concentrated on "Advanced methods to model and predict space weather effects". The work was performed in four subgroups, each emphasising a specific domain: - SG 1.1: Progress in scientific understanding of space weather - SG 1.2: Performance of available research and operational models - SG 1.3: Improvement of operational models - SG 1.4: Codes for new space weather products and services Most COST ES0803 participants are scientists, consequently WG1 - and within it SG1.1 – attracted the interest of the majority of the participants. Considering that COST only funds coordination and networking not all potential space weather themes were addressed, only those to which participants contributed using support from other sources of funding. Areas covered in WG1 included - Sources of solar activity - Solar wind perturbations and solar energetic particles - Solar wind - geospace coupling - Space radiation in the Earth environment - Geomagnetic activity and geomagnetic indices - Monitoring, modeling, nowcasting and forecasting the state of the ionosphere - Ionospheric electrodynamics and plasma transport in the upper atmosphere - Ground effects of space weather - Advances in numerical modeling and coding - Performance of space weather models Most contributions to WG1 addressed research on the scientific basis of space weather, but a considerable amount of work was performed in other areas such as performance evaluation of space weather models and improvements of operational models for space weather nowcast and forecast purposes. Addressed in this talk will be a selection of achievements from a subset of domains: solar wind disturbances and their interaction with the Earth environment and ground effects of space weather. The following topics will be dealt with in companion talks and are not considered here: solar activity and its evolution across the solar corona, monitoring, modeling, nowcasting and forecasting the state of the ionosphere using radio methods, space weather effects on the polar cap ionosphere, performance evaluation and validation of space weather models, space weather models in an operational environment.

Solar activity and its evolution across the corona

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Solar magnetism is responsible for many activity phenomena occurring in the solar atmosphere. The consequences of these phenomena on the solar-terrestrial environment and on Space Weather are nowadays clearly recognized, even if not yet fully understood. In order to shed light on the mechanisms that are at the basis of the Space Weather, it is necessary to investigate the sequence of phenomena, starting in the solar atmosphere and developing across the outer layers of the Sun and along the path from the Sun to the Earth. This goal can be reached by a combined multidisciplinary, multi-instrument, multi-wavelength study of these phenomena, starting from the very first manifestation of solar active region formation and evolution, to the analysis of explosive phenomena (i.e., flares, erupting prominences, coronal mass ejections), till the study of the interaction of plasma magnetized clouds expelled from the Sun with the interplanetary magnetic field and medium. The state of the art of our comprehension of these phenomena is briefly reviewed, focusing on the results obtained during the COST Action ES0803.

Solar activity impact on the Earth’s upper atmosphere

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A number of studies have been conducted in the frame of subgroup (SG)1.1 of COST ES0803 devoted to the solar activity impact on the Earth’s upper atmosphere. Response of the thermosphere and ionosphere to the changes of solar activity is important part of the space weather issue, because of its impact on the human space-based activity. The studies cover wide range of contemporary topics identified in the Action’s scientific program. The methods described here are based on data-driven analysis. Specific databases are used for spectrum analysis, empirical modeling, electron density profile reconstruction and forecasting techniques. The results of the studies can be grouped in three major topics. One is the response of the ionosphere to the periodic changes of solar activity with time scale from several days to a month (medium-term response) and those with time scale of order of several solar cycles. The second group of topics covers studies on the ionospheric response to geomagnetic storms, which have time scale from several hours to 2-3 days. Third group contains development of empirical models and forecasting techniques, which are aimed to feed the space weather operational services.

Space Weather Challenges of the polar cap Ionosphere

Moen, Joran[1]; Oksavik, Kjellmar[2]; Alfonsi, Lucilla[3]; Barthémely, Mathieu[4]; Daabakk, Yvonne[5]; Lilensten, Jean[4]; Romano, Vincenzo[3]; Spogli, Luca[3]
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We present a review of research on polar cap ionosphere space weather conducted during the COST action ES0803. The main part of the work has been directed towards the study of plasma instabilities and scintillations in association with cusp flow channels and polar cap patches, which is considered as critical knowledge in order to develop forecast models for scintillations in the polar cap. We have conducted these studies by multi-instrument techniques comprising the EISCAT Svalbard Radar, SuperDARN radars, in-situ rocket measurements, and GPS scintillation measurements. The cusp ionosphere is a hot region in scintillation climatology maps. Scintillations in the cusp and the polar cap ionosphere are due to multi-scale structures in the electron plasma. The ionosphere is associated with filamentary precipitation giving rise to km scale gradients onto which the gradient drift instability can operate very efficiently. The cusp is also associated with strong flow shears ideal for the Kelvin-Helmholtz instability process, meaning that in the cusp there are two generic instability processes that can operate simultaneously. For IMF Bz negative conditions, high density solar EUV ionized plasma produced at subauroral latitudes enters the polar cap in the form of polar cap patches near the cusp inflow region. The polar cap patches are subject to the gradient drift instability as they convect across the polar cap, exit the night time polar cap, and enter the auroral oval. We have demonstrated that the SuperDARN convection model can be used to track these patches backwards and forward in time. Hence, once a patch has been detected in the cusp inflow region, SuperDARN can be used to forecast its destination in the future. We have also explored the potential of using the polarization rate of the red oxygen line as an additional space weather parameter. Polarization can possibly be used as a proxy for the neutral atmospheric density and particle precipitation as the depolarization rate is controlled by atmospheric conditions and altitude of emission. However, a main concern for the practical use of polarization measurements in space weather monitoring is the extraordinary high requirement for clean measurements or for a thorough monitoring of the light pollution.

Verification of space weather models

Wintoft, P.; Buresova, D.; Bushell, A.; Hejda, P.; Innocenti, M.E.; Lapenta, G.; Nunez, M.; Perrone, L.; Qahwaji, R.; Thomson, A.; Tsagouri, I.; Valach, F.; Viljanen, A.
IRF

Working group 1.2 of COST Action ES0803 addressed the problem of verification of space weather models. For this purpose a survey of current space weather model verification were carried out, with focus on models and algorithms developed by institutes participating in COST Action ES 0803. Many different approaches exist although a small collection of measures are most often used. We describe verification approaches taken both from the meteorological and space weather communities. The most common approach is to use one, or a few, metrics to verify the models. It is recommended that the more advanced approaches, like the distributions oriented, used in meteorology are also used for the space weather model verification.

Progress in space weather modeling in an operational environment

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National Observatory of Athens

This contribution aims to review latest advances in space weather modeling in an operational environment in Europe including both the introduction of new models and the improvements to existing codes and algorithms that address the broad range of space weather's prediction requirements from the Sun to the Earth. Each case is addressed by considering the input data, the output parameters, products or services, its operational status and whether it is supported by validation results, aiming to provide a solid basis for future developments. This work is the output from the Sub Group 1.3 "Improvement of operational models" of the COST ES0803 action and the emphasis is given on the progress achieved by European research teams involved in COST ES0803.

Recommendations for space weather products and services in Europe

Van der Linden, R.[1]; Hapgood, M.[2]; Heynderickx, D.[3]; Stanislawska, I.[4]; Belehaki, A.[5]; Messerotti, M.[6]
[1]Royal Observatory of Belgium; [2]RAL; [3]DHC; [4]SRC, PAC; [5]NOA; [6]INAF

This presentation summarises the results of a key activity implemented in the frames of the Working Group 2 of the COST Action ES0803. Main outcome concern the identification of space weather services in Europe, the specification of the users' requirements for different domains affected by space weather and recommendations for space weather products and services that can support further the needs of the users. Recommended space weather products are mainly based on specific operational programmes that have been developed recently by the European researchers. Finally, some conclusions are presented regarding the future perspectives of space weather advances in Europe.

Where communication and space weather meet

Vanlommel, Petra
Solar-Terrestiral Centre of Excellence-STCE

Research, including observations, instrumentation and product development are the goals of scientists working in the field of space weather. A publication in a refereed journal about this research and development is a justification and validation of the work performed. However, these results should go beyond a publication and beyond the scientific community. Dissemination, exploitation and education of space weather science provide the tools to make this extra step. Also, space weather projects and the space weather community in general have been putting a larger emphasis on this the last few years. We will present the communication efforts done in the frame of the COST action 'Developing Space Weather Products and Services in Europe'.

"Networking for space weather outreach activities: the Planeterrella example"

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Institut de Planétologie et d'Astrophysique de Grenoble (IPAG)

The planeterrella is an auroral simulator conceived for space weather outreach activities. It was created in France in 2007 and gradually improved. Several copies exist in different countries, which allowed about 50,000 people to picture auroras in Europe. More copies are under way. The spreading of this experiment is mainly based on the scientific network created through COST or other European instruments. In this lecture, I will present the experiment, and discuss the pros and cons of its economic model: small versus big, automated versus operated, patent versus gentleman agreement, centralized diffusion versus networking, owned experiment versus shared knowledge.

The Effects of solar Activity onto Transformers in the Greek National Electric Grid

Zois, Ioannis; Zois, IoannisOANNIS
PPC

We are reporting on effects (both short and long term) of solar activity onto the greek national electric grid, in particular large transformers from 1989-2010. I do not think this topic fits in any of the prescribed categories. In 8ESWW last year there was a splinter on GIC's where some preliminary results were presented. More results are available now: Immediate-short term effects contain a list of transformer failures during stormy days (Ap>100). Long term effects are studied using statistical regression and correlation (both linear and non-linear models).

Cosmic ray Measurements at the Geophysical Centre of Dourbes

Sapundjiev, Danislav; Nemry, Myriam; Stankov, Stanimir; Spassov, Simo; Jodogne, Jean-Claude
Royal Meteorological Institute (RMI)

Cosmic rays or cosmic radiation is the common name for the particles and photons which are reaching us from the outer space or from the cosmos. Ever since their discovery by Victor Hess, they have been an interesting research topic; however, despite the huge technological and scientific progress, there are still a number of open questions, including the mechanism responsible for the very high energies of cosmic ray particles, the origin of the electron component in the cosmic rays and more important the effect of cosmic radiation intensity on space weather. Cosmic ray intensity has been correlated to the production of ozone in the atmosphere, to the occurrence of cloud anomalies and to the occurrence of geomagnetic storms resulting from high solar activity. It has been shown, that it is possible to use variations in cosmic ray intensity as a precursor for ground level enhancements (GLE) and 'Forbush decrease (FD) events. Cosmic rays are studied by a variety of detector systems, situated on the Earth's surface, which are designed to detect mainly the secondary particles resulting from interactions of the primary cosmic ray particles with the atmosphere. About 90 % of the primary cosmic radiation consists of charged particles which are deflected by the geomagnetic field. The energy spectrum of the cosmic rays above the atmosphere is measured by a worldwide network of measurement stations, thus utilising the magnetic field as a spectrometer. The Royal

Meteorological Institute (RMI) operates a standard 9-NM64 neutron monitor located at the RMI Geophysical Centre in Dourbes and provides real time data to the international Neutron Monitor Database (NMDB). In this presentation, we will outline the operational principles/characteristics of the neutron monitor, present the Dourbes cosmic ray observatory, the (real-time) data processing, and will discuss possible applications of these measurements.

Multi-Point Observations of the Solar Corona for Space Weather

Legg, Stephen[1]; Glover, Alexi[2]; Luntama, Juha-Pekka[3]
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Coronal Mass Ejections (CME) are an important element of space weather forecasting. Interacting with the magnetosphere, they can cause geomagnetic storms affecting many of the key systems on which our society relies. The LASCO coronagraphs onboard the SOHO spacecraft have been providing regular CME data for more than 15 years from an orbit around the Sun-Earth L1 point. More recently, with the launch of STEREO we have gained new instrumentation and vantage points, allowing imaging along the whole Sun-Earth line.

The aim of this project is to consider CME observations from multiple vantage points, as viewed from a space weather forecasting perspective. Currently occupied vantage points will be discussed and example Earth directed events analysed. Additional possible vantage points will also be considered, along with their potential impact on forecasting capability.

ODI - Open Data Interface

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The Open Data Interface (ODI) is a database system for storing space environment data and metadata using an SQL server. The system is compliant with the SPASE data model. Data can be ingested from text files and CDF/ISTP/PRBEM files. Currently there are more than 100 datasets in the database such as IMP8/GME, SREM, XMM/ERMD, GOES particle and radiation data, and indices such as Dst, Kp, and SSN. Adding new datasets is straightforward. If the raw data to be ingested are CDF files these are automatically converted before the data are stored into ODI. For non-CDF files, like plain text files, a few lines of code need to be edited to correctly parse the raw data files. As ODI is based on SQL it is accessible to a large range of different software platforms. As part of the development, interfaces to IDL, PHP, Python, Matlab and Java have been developed, but the ODBC interface also can provide direct access from many other programs. Interfaces to existing platforms can therefore be set up and applications have been updated to connect to the ODI system like SAAPS, SEDAT, and SPENVIS. ODI is now at version 4 with major updates of the core system.

Secular Changes of ionospheric Characteristics measured by Warsaw Ionosonde.

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[1]Space Research Centre; [2]Space Research Center

Ionospheric measurements carried out (with some gaps) in Warsaw in period from 1958 to the present day. Initially were conducted by The National Institute of Telecommunication, after 1989 measurements were moved to the Space Research Centre. The standard procedure determines critical frequency and height of F2, F1 end E layer. Such a long period of measurements covering nearly 5 solar cycles gives the opportunity to explore long-term (secular) changes in ionospheric parameters. These measurements also allow for comparison with results of similar analyses carried out at other ionosonde station. During the study were also compared the differences between parameters given by CCIR coefficient and the measured characteristics. During the analysis we looked into detail of the differences between solar activities of consecutive cycles.

Hungarian Stratospheric Cosmic Radiation Measurements to study the Effects of the Space Weather

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Due to significant spatial and temporal changes in the cosmic radiation field, radiation measurements with advanced dosimetric instruments on board spacecrafts, aircrafts and balloons are very important. Considering the space weather effects in the near Earth region the first measurement stage is sun-orbiting satellites, the second one is Earth-orbiting satellites, the third one is measurements on board ISS and the final stage would be a balloon measurement platform in the stratosphere. The Hungarian CoCoRAD Team was selected to take part in the BEXUS (Balloon Experiment for University Students) 12&13 project. In the frame of the BEXUS programme Hungarian students from the Budapest University of

Technology and Economics carried out a radiation and dosimetric experiment on a research balloon, which was launched from Northern Sweden in September 2011. As an extension and improvement of the CoCoRAD a new experiment - called TECHDOSE - is expectedly launched in the 2012's BEXUS Launch Campaign at the end of September. The main goal of these experiments is to develop a platform for cosmic radiation measurements on board stratospheric balloons which is capable of measuring most of the particles in the stratosphere. In the ESWW conference last year we presented the preliminary results of the CoCoRAD experiment. The present paper will summarise the final results of the CoCoRAD measurements and give a first overview about the TECHDOSE new measurement results. A comparison of the results of the two experiments will be also provided in the light of the solar activity.

Global Model of lower Band and upper Band Chorus from multiple Satellite Observations

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Gyroresonant wave particle interactions with whistler mode chorus play a fundamental role in the dynamics of the Earth's radiation belts and inner magnetosphere, affecting both the acceleration and loss of radiation belt electrons. Knowledge of the variability of chorus wave power as a function of both spatial location and geomagnetic activity, required for the computation of pitch angle and energy diffusion rates, is thus a critical input for global radiation belt models. Here we present a global model of lower band (0.1fce<f<0.5fce) and upper band (0.5fce<f<fce) chorus, where fce is the local electron gyrofrequency, using data from five satellites, extending the coverage and improving the statistics of existing models. From the plasmapause out to L*=10 the chorus emissions are found to be largely substorm dependent with the largest intensities being seen during active conditions. Equatorial lower band chorus is strongest during active conditions with peak intensities of the order 2000 pT^2 in the region 4<L*<9 between 2300 and 1200 MLT. Equatorial upper band chorus is both weaker and less extensive with peak intensities of the order a few hundred pT^2 during active conditions between 2300 and 1200 MLT from L*=3 to L*=7. Moving away from the equator mid-latitude chorus is strongest in the lower band during active conditions with peak intensities of the order 2000 pT^2 in the region 4 <L*<9 but is restricted to the dayside between 0700 and 1400 MLT.

Space Weather Drivers: Outstanding Scientific Questions and Modelling Challenges of the Inner Magnetosphere

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Finnish Meterological Institute

Energetic charged particles trapped in the inner magnetosphere (radiation belts and ring current) are a major source of damaging space weather effects on life and society here on Earth. While these energetic electrons and ions may not carry the bulk of the plasma mass or energy content, they directly and adversely affect space-based technological assets and they pose a serious risk of harm to astronauts. Understanding the physical processes that enhance the ring current and radiation belts is, therefore, a timely and pressing issue. The problem is, however, that everything seems to happen at once, with competing source and loss processes driven by the same external factors. In addition, the fast speed of these particles makes the problem global in nature. The ring current is a key current system in the inner Earth's magnetosphere and a defining element of magnetic storms. There are two primary external drivers of the ring current to consider: the source population and the sunward force within the magnetosphere. For the former, there are questions about solar wind entry mechanisms into the magnetosphere, ionospheric outflow rates and acceleration in the magnetosphere, and the recirculation of magnetospheric plasma back into the magnetotail. For the latter, there are issues regarding the distribution of the convection electric field in the magnetosphere, electric potential saturation, and the relative role of convection versus substorm inductive electric fields in supplying plasma to the inner magnetosphere. The existence of the partial (rather than symmetric) ring current leads to the distortion of the magnetic and electric fields in near-Earth space and therefore to nonlinear feedbacks on the ring current itself. This influence of the ring current on its further development is a critical unknown that is just beginning to be explored by the magnetospheric physics community. In addition to these issues, there are still concerns about the dominant loss mechanisms of the ring current. In particular, there is debate about when flow-out loss to the magnetopause is larger than charge exchange loss within the magnetosphere. Recent studies have clarified this, but questions remain about when and how these two loss mechanisms relate to the ring current drivers and morphology. Ring current is a catalyst of many space weather phenomena. There is uncertainty, however, in predicting the strength and morphology of the ring current because it depends on the nonlinear combination of several source populations and physical mechanisms. Large-scale, systematic investigation of the physical processes controlling the flow of particles into and through the inner magnetosphere is presented using

Inner Magnetosphere Particle Transport and Acceleration Model (IMPTAM), developed by Ganushkina et al. [2001, 2005, 2006], which is a tool to model and forecast the behavior of ring current and radiation belts particles in the inner Earth's magnetosphere. We demonstrate the ability to model the development of the ring current during storms and to produce seed electron population to be further accelerated to radiation belts energies.

The Sheffield Forecast Tool for the relativistic Fluxes at Geostationary Orbit.

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[1]University of Sheffield; [2]ACSE, The University of Sheffield

The Sheffield online forecast of daily fluxes at geostationary orbit became operational in spring 2012. The forecast is based on the mathematical model identified in the frame of the systems approach to complex dynamical systems. For the first stage, an orthogonal least squares technique was used to identify solar wind parameters that control fluxes of electrons for different energy ranges. For the second stage, NARMAX models for various energy ranges were identified. The Sheffield model forecast reliability is compared with other available online tools. In addition to providing the reliable online 24 hours ahead forecast the identified models are able to advance physical insight into the evolution of the fluxes at the geostationary orbit. In particular, it will be shown how the results of the orthogonal least squares technique can be used to differentiate between effects of radial and local energy diffusion.

CME flank Kinematics derived by the constrained Harmonic Mean Method

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Understanding the evolution of coronal mass ejections (CMEs), their directions and kinematics, is essential in order to enhance existing forecasting methods. Using a numerical simulation we validate the constrained Harmonic Mean method, that is used to derive speed profiles of CMEs from close to the Sun up to 1 AU by combining remote sensing and in situ data. The event of 07 August 2010 is simulated by using the numerical heliospheric code ENLIL. This model provides, besides modeled in-situ data at the s/c positions from STEREO-B, Wind and VEX, the top view of the CME as well as synthetic heliospheric images as observed by STEREO-A and STEREO-B. These two view points, from top and from aside, give us the possibility to compare the resulting kinematics yield by the constrained Harmonic Mean method to the actual speed profile of the modeled CME. In this vein we assess the ability of the constrained Harmonic Mean method to provide apex and flank kinematics for CMEs. This work has received funding from the European Commission FP7 Project COMESEP (263252).

Statistical Study of false Alarms of geomagnetic Storms

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[1]DTU Space; [2]UNIGRATZ; [3]ROB; [4]HVAR Observatory

Coronal Mass Ejections (CMEs) are known to cause geomagnetic storms on Earth. However, not all CMEs will trigger geomagnetic storms, even if they are heading towards the Earth. In this study, frontside halo CMEs with speed larger than 800 km/s have been identified from the SOHO LASCO catalogue. A subset of these halo CMEs did not cause a geomagnetic storm the following four days and have therefore been considered as false alarms. The properties of these events are investigated and discussed here.
The ability to identify potential false alarms is considered as an important factor when forecasting geomagnetic storms.

This work has received funding from the European Commission FP7 Project COMESEP (263252)

Using a Centralised Database System and Server in the European Union Framework Programme 7 Project SEPServer

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The main objective of the SEPServer project (EU FP7 project 262773, coordinated by the University of Helsinki) is to produce a new tool, which greatly facilitates the investigation of solar energetic particles (SEPs) and their origin: a server providing SEP data, related electromagnetic (EM) observations and analysis methods, a comprehensive catalogue of the observed SEP events, and educational/outreach material on solar eruptions. The project combines data and knowledge from 11 European partners and several collaborating parties from Europe and the US.

The datasets provided by the consortium partners are collected in a MySQL database (using the ESA Open Data Interface under licence) on a server operated by DH Consultancy, which also hosts a web interface providing browsing, plotting and post-processing and analysis tools developed by the consortium, as well as a Solar Energetic Particle event catalogue. At this stage of the project, a prototype server has been established, which is presently undergoing testing by users inside the consortium.

Using a centralized database has numerous advantages, including:

- homogeneous storage of the data, which eliminates the need for dataset specific file access routines once the data are ingested in the database;
- a homogeneous set of metadata describing the datasets on both a global and detailed level, allowing for automated access to and presentation of the various data products;
- standardised access to the data in different programming environments (e.g. php, IDL);
- elimination of the need to download data for individual data requests.

SEPServer will thus add value to several space missions and Earth-based observations by facilitating the coordinated exploitation of and open access to SEP data and related EM observations, and promoting correct use of these data for the entire space research community. This will lead to new knowledge on the production and transport of SEPs during solar eruptions and facilitate the development of models for predicting solar radiation storms and calculation of expected fluxes/fluences of SEPs encountered by spacecraft in the interplanetary medium.

Australian Regional Ionospheric Disturbance Index based on the Principal Component Analysis and GPS Data.

Bouya, Zahra
Australian Bureau of Meteorology

In this paper, a new Australian Regional Ionospheric Disturbance Index (AusRDI) is introduced using Spherical Cap Harmonic Analysis (SCHA) and Principal Component Analysis (PCA) techniques. AusRDI is defined as the relative deviation of the vertical Total Electron Content. (TEC). The SCHA method was firstly used to estimate TEC at evenly distributed grid points from GPS data collected from the Australian Regional GPS Network (ARGN). PCA was then used to decompose the TEC dataset into a series of orthogonal Eigenfunctions (EOF base functions) and associated coefficients. The base function represents the variation in TEC with latitude and longitude. PCA is non parametric and as such does not utilize deviation from a previously described average to determine perturbations. It is used as a potentially useful method for detecting and describing the TEC disturbance during storm time. Specifications of the TEC variations are discussed and criteria for identifying TEC storm event are proposed. This approach will provide reliable ionospheric characterization during all possible ionospheric conditions for operational applications with high temporal and spatial resolution . Keywords: PCA, Disturbance Index, Regional, SCHA, TEC, GPS, Australia .

Indicators of geomagnetically induced Currents in power Networks: (in)Sensitivity to model Parameters

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[1]Finnish Meteorological Institute; [2]Geodetic and Geophysical Institute, RCAES, HAS

The basic modelling method of geomagnetically induced currents (GIC) in power networks assumes that (1) the locations of transformer stations (nodes) and transmission lines as well as all DC resistances are known, and that (2) the geoelectric field is known in the area of the power grid. The EU/FP7 project EURISGIC (European Risk from Geomagnetically Induced Currents) considers the whole European area with a prototype grid model of about 1800 nodes and 2400 transmission lines. The model imitates the true configuration, but it contains simplifications such as a reduced number of substations and lines and approximate estimates of resistances. The ground conductivity models also contain inaccuracies, which affect the modelled geolectric field and GIC. Considering these uncertainties, a question arises if we can still obtain a reasonable overall understanding about the occurrence of GIC. We have performed systematic tests to study the variability of GIC indicators (such as the sum of the absolute values of GIC to the ground at substations) with (1) fixed power grid models and varying conductivity models, and with (2) fixed conductivity models and varying power grid parameters. Of special interest is to investigate whether some sites can always experience large GIC even if the nearby power grid configuration is changed.

Space Situational Awareness Services offered by PROBA2

Bonte, Katrien[1]; Dammasch, Ingolf[2]; Verstringe, Freek[2]; Berghmans, David[2]; De Groof, Anik[2]; Dominique, Marie[2]; Kretzschmar, Matthieu[2]; Nicula, Bogdan[2]; Pylyser, Erik[2]; Seaton, Dan[2]; Stegen, Koen[2]

[1]Centre for mathematical Plasma Astrophysics; [2]Royal Observatory of Belgium

PROBA2 is an ESA micro-satellite in orbit since end 2009. Besides two in-situ plasma instruments, the science payload consists of the solar monitoring instruments SWAP and LYRA. SWAP is an EUV imager observing the million degree solar corona at a minute cadence while LYRA is an (E)UV radiometer sampling non-stop at a nominal rate of 20Hz. In this paper we concentrate on recent software developments for the SWAP and LYRA data to deliver a full flare monitoring service. We present the new LYRA data product that shows flare timelines in the same format as the familiar ABCMX-scaling from the NOAA GOES SXR instrument. In addition we show the "soFAST" automated processing pipeline to detect the occurrence and location of flares in the SWAP EUV image series. These results are fused into a dedicated webpage for flare monitoring http://proba2.oma.be/ssa . We believe that such a flare monitoring service based on an ESA microsatellite can be a prototype in the future space segment of ESA's Space Situational Awareness Program. We additionally discuss the further possibilities concerning event catalogues and flare alert messages.

Near-real time Forecast of the Dst Index

Parnowski, Aleksei; Polonska, Anna; Semeniv, Oleg; Cheremnykh, Oleg; Yatsenko, Vitaliy; Kuntsevich, Vsevolod; Salnikov, Nikolai; Kremenetsky, Igor

Space Research Institute

We demonstrate the storm-time performance of a software tool for near-real time forecasting of geomagnetic indices. This software tool will be integrated into DLR's SWACI system as an operational Geomagnetic Forecast Module of the Forecast System Ionosphere.

Live presentation of near-real time forecasting will be given at the AFFECTS User Workshop (to be announced separately).

The research leading to these results has received funding from the European Commission's Seventh Framework Programme (FP7/2007-2013) under the grant agreement [1] 263506 (AFFECTS project, www.affects-fp7.eu).

Solar microwave Precursors of geoeffective Coronal Mass Ejections

Sheiner, Olga; Fridman, Vladimir

Radiophysical Research Institute

The issues of studying of geoeffectiveness of coronal mass ejections and their influence on the parameters of the near-Earth space involve analysis of and allowance for the types of the coronal mass ejections, their interaction with the near-Earth space, and the characteristics of their geoeffective manifestations. In this work, we have studied the features of the sporadic solar microwave emission which precedes recording of the geoeffective coronal mass ejections on the basis of the broadband patrol observations of the Sun in the radio range, which cover the centimeter-, decimeter-, and meter-wave ranges in some periods of the XXIst–XXIIIrd solar-activity cycles. It has been shown that a significant number of coronal mass ejections in a two-hour interval before their recording by coronagraphs are preceded by sporadic radio emission that can be defined as radio precursors of coronal mass ejections. The following regular features of the existence of radio precursors of such coronal mass ejections whose effect on the near-Earth space is accompanied by variations in the geomagnetic indices (Kp and Dst) have been established on the basis of statistical consideration: the presence of the broadband radio emission of radio precursors of coronal ejections at least in one wavelength range, centimeter or decimeter; radio-precursor duration exceeds 10 min.
It is confirmed that halo and partial halo coronal mass ejections, the most geoeffective coronal mass ejections, are preceded by radio precursors which cover the centimeter- and decimeter-wave ranges and have the special features, namely, the radiation component possessing similar temporal behavior at various frequencies of the microwave range with a gradual increase and subsequent decrease in the flux, which simultaneously emerges in the entire microwave range. It is confirmed that in cases where the source of coronal mass ejections is located at the western edge of the solar disk or behind its limb, the broadband radio precursors are absent due to the radiation directivity effect, whereas geoeffective manifestations of the halo and partial halo coronal ejections are possible. In conclusion, it should be emphasized that allowance for the effects in a wide spectrum of electromagnetic waves, including the microwave radiation, in the stage of formation and initial propagation of coronal mass ejections seems a necessary step in the complex approach to considering geoeffectiveness of coronal ejections and their influence on the parameters of the near-Earth space.

The Structure and Radial Propagation of Magnetic Clouds in the Solar Wind from the Sun to 1.78 AU.

Ibsen, Tina[1]; Vennerstrom, Susanne[1]; Temmer, Manuela[2]; Möstl, Christian[2]; Veronig, Astrid[2]
[1]National Space Institute, Technical University of Denmark; [2]Institute of Physics, University of Graz

The magnetic structure of five ICMEs with MC parts have been examined by using data from the ACE and NEAR spacecraft. During July and August 2000, NEAR had a longitudinal separation to ACE of less than 15°, and had a distance to the Sun of ~1.78 AU. Only three of the five ICMEs observed by ACE were observed by NEAR. All of the observed ICMEs were analyzed by using a minimum variance analysis (MVA) in order to determine their orientation. It was found that the orientation in some cases were highly dependent on the chosen boundaries of the MC, and as only magnetic field data were available from the NEAR spacecraft the boundaries were difficult to determine. Therefore a large number of different boundaries, and boundary combinations were tested and the final boundaries used for the MVA were found by using a number of criteria. It was found that the handedness remained the same in the MC at both ACE and NEAR, and that the orientation maximally varied 45°. The solar source was found for four of the events, and three of these were associated with a flare leaving behind a post-flare loop. The handedness of the post-flare loop was determined and it was the same as seen in the associated MCs in all three cases.

This work has received funding from the European Commission FP7 Project COMESEP (263252).

Impact of a solar radio Burst on the EPN GNSS Network

Marqué, Christophe; Bergeot, Nicolas; Aerts, Wim; Chevalier, Jean-Marie; Magdalenic, Jasmina; Nicula, Bogdan
Royal Observatory of Belgium

On September 24 2011, NOAA Active Region 1302 produced a M7.1 flare accompanied by an intense radio burst observed by the Radio Solar Telescope Network of the US Air Force Weather Agency. For several minutes, the flux at 1415 MHz was greater than 60000 SFU, and even intermittently fluctuated up to 100000 SFU. This event was strong enough to affect the reception of GNSS signals (1575 and 1227 MHz) at several stations of the EUREF Permanent Network. We discuss in detail how the carrier power to noise density (C/N0) observations of the receivers in the network were affected during this event. We also investigate the parameters, which influence the most the sensitivity of an individual station to a solar radio burst.

GPS and Ionosonde Measurement at the Pruhonice Station

Mosna, Zbysek; Kouba, Daniel; Boska, Josef; Lastovicka, Jan; Jackova, Katerina; Buresova, Dalia; Koucka Knizova, Petra
Institute of atmospheric physics, Academy of Sciences

Total electron content (TEC) is an important parameter influencing the propagation of electromagnetic signals (e.g., from GNSS). The GPS measurement (Topcon NET-G3) has been carried out at the Pruhonice station (Czech Republic, 49N, 15E) together with the digisonde DPS-4D measurement which gives relatively unique combination of ionospheric observation. Results from the GPS compared to the digisonde measurement and the model of electron concentration are compared to study ionospheric responses under geomagnetically quiet and stormy situation.

A Database of >20 keV Electron Green's Functions of Interplanetary Transport at 1 AU

Agueda, Neus[1]; Vainio, Rami[2]; Sanahuja, Blai[1]
[1]University of Barcelona; [2]University of Helsinki

We use interplanetary transport simulations to compute a database of electron Green's functions, i.e., differential intensities resulting at the spacecraft position from an impulsive injection of energetic (>20 keV) electrons close to the Sun, for a large number of values of two standard interplanetary transport parameters: the scattering mean free path and the solar wind speed. The nominal energy channels of the ACE, STEREO and Wind spacecraft have been used in the interplanetary transport simulations to conceive a unique tool for the study of near-relativistic electron events observed at 1 AU. The database will be publicly available through the EU/FP7 project SEPServer website.

In this presentation, we use the database to quantify the Green's functions characteristic times (onset and peak time, rise and decay phase duration) as a function of the interplanetary transport conditions. We also provide an estimation of the full width at half maximum of the pitch-angle distributions at different times of the event and under different scattering conditions. This allows us to provide a first quantitative result that can be compared with observations, and that allows an assessment of the validity of the frequently used term *beam-like* pitch-angle distribution.

ULF wave Observations from multiple space Missions and ground-based Instruments using a wavelet analysis Tool

Balasis, Georgios[1]; Daglis, Ioannis A.[1]; Georgiou, Marina[2]; Papadimitriou, Constantinos[2]; Anastasiadis, Anastasios[1]; Haagmans, Roger[3]
[1]National Observatory of Athens; [2]National Observatory of Athens; Department of Physics, University of Athens; [3]European Space Agency / European Space Research and Technology Centre

We examine data from two magnetospheric and a topside ionosphere missions (Cluster, Geotail and CHAMP) as well as ground-based magnetometer networks (e.g. IMAGE) for signatures of ULF waves during the 2003 Halloween geospace magnetic superstorm. We use a suite of wavelet-based algorithms, which are a subset of a tool that is being developed within the context of "Multi-satellite, multi-instrument and ground-based observations analysis and study of ULF wave phenomena and products" (ULFwave), an ESA funded study. We provide evidence for the occurrence of a number of prominent ULF wave events in the Pc 3-5 bands during the storm and offer a platform to study the wave evolution from high magnetic latitudes to low Earth orbit (LEO) and ground. The solid results confirm the applicability and the potential of our wavelet-based algorithms for the analysis of multi-instrument multi-satellite observations and the detection, identification and classification of ULF waves. In the past decade, a critical mass of high-quality scientific data on the electric and magnetic fields in the Earth's magnetosphere has been progressively collected. This data pool will be further enriched by the measurements of the upcoming ESA/Swarm mission, a constellation of three satellites in three different polar orbits between 400 and 550 km altitude, which will be launched by the end of 2012. New analysis tools that can cope with measurements of various spacecraft at various regions of the magnetosphere, like the ones used in the present study, will effectively enhance the scientific exploitation of the accumulated data. The ULFwave study is funded by ESA under contract ESTEC 4000103770/11/NL/JA/ef.

A complete Database of solar Indices and Proxies

Dudok de Wit, Thierry[1]; Bruinsma, Sean[2]; Vieira, Luis[3]; Vuiets, Anatoliy[3]
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Many users heavily rely on various proxies for solar activity, such as the MgII index for the UV, or the daily sunspot area for sunspot darkening. Unfortunately, many of these quantities suffer from outages or outliers, which impedes their routine use for event analysis or for doing statistics. However, all of these quantities are correlated, which opens the way for reconstructing at least part of the missing information. We use a recent Bayesian and multiscale method and show how the data gaps (from days to months) can be filled in with high fidelity, using the correlation. The results can be tested by bootstrapping. For several proxies such as the MgII and CaK indices, the reconstruction error is comparable to the uncertainty of the observations.

Based on this approach, we provide an online database of daily values of >12 solar proxies from 1978 till today, without any data gaps and including confidence intervals. This work was partly supported by COST action ES1005 and by the FP7 ATMOP project.

Statistical Models relating geomagnetic Activity to Coronal Mass Ejections (CMEs)

Devos, Andy[1]; Dumbović, Mateja[2]; Rodriguez, Luciano[1]; Robbrecht, Eva[1]; Vršnak, Bojan[2]; Sudar, Davor[2]; Ruždjak, Domagoj[2]; Dierckxsens, Mark[3]; Veronig, Astrid[4]; Temmer, Manuela[4]; Vennerstrom, Susanne[5]; Leer, Kristoffer[5]
[1]Royal Observatory of Belgium; [2]Hvar Observatory; [3]BIRA-IASB; [4]Institute of physics, University of Graz; [5]DTU

Coronal Mass Ejections (CMEs) are very important in terms of space weather because they can be highly geoeffective. As part of the FP7 project COMESEP (COronal Mass Ejections and Solar Energetic Particles: forecasting the space weather impact), a statistical analysis is being carried out in order to investigate the impact of CME parameters and their associations to geomagnetic storms.

A list of 225 front-sided, flare associated CMEs, with a minimal speed of 400 km/s, were randomly selected from the LASCO/SOHO catalog and associated with a specific Dst (disturbance storm time) index. This way a sample was made containing both geoeffective, non-geoeffective and CMEs which missed the Earth. The last was derived using the in-situ data and CME-ICME-Dst list made by Richardson&Cane (2010).

Statistical analysis was then applied to detect relationships between CME parameters, such as speed, width, source region location, brightness, and the Dst value. In case of flare related CMEs, the X-ray intensity and class were also included. We also investigated how much the occurrence of multiple CMEs increases the probability of large Dst values.

Bivariate as well as multivariate analysis currently are being set up and tested. The bivariate analysis focuses on the probability distributions of Dst depending on the CME (or flare) characteristics. The multivariate analysis develops models using logistic regression and decision trees. Models are evaluated using resampling techniques. This work has received funding from the European Commission FP7 Project COMESEP (263252).

Statistical Evaluation of space weather Forecasting at the Regional Warning Center in Belgium

Devos, Andy; Verbeeck, Cis; Robbrecht, Eva; Vanlommel, Petra
Royal Observatory of Belgium

For more than a decade, the ISES Regional Warning Center Brussels for space weather forecasting at the SIDC of the Royal Observatory of Belgium (ROB) has been providing daily space weather forecasts. As part of the FP7 project AFFECTS (Advanced Forecast For Ensuring Communications Through Space), ROB has started a thorough statistical evaluation to assess the quality of the past and current forecasts of the RWC. This procedure will from now on be applied routinely as constant quality control.

Forecasts of fundamental space weather parameters as the K value (the local geomagnetic index), the 10.7 cm radio flux and solar flaring probabilities are under evaluation. Quality of forecasts is compared to that of common numeric models as persistence, 27 day recurrence and linear regression models. The system has been designed to facilitate embedding new forecasting models in the future.

Descriptive model statistics, residual plots and conditional plots between forecasts and observations are produced in any time period, such as on a monthly and yearly basis or in periods of high or low solar activity. This allows us for example to detect the influence of solar activity on the confidence level of the forecasts. This analysis aids to identify the strong and weak points of RWC forecasting as well as those of the models considered. As such, it creates the opportunity to continuously reevaluate and increase the reliability of space weather forecasting.

This work has received funding from the European Commission FP7 Project AFFECTS (263506).

The publicly available real-time Ionosphere Service of the NMA

Jacobsen, Knut Stanley; Schäfer, Sebastian
Norwegian Mapping Authority

At high latitudes, disturbances in the ionosphere frequently disrupts satellite-based services, including the GNSS-based positioning services of the Norwegian Mapping Authority (NMA).

NMA has developed a real-time ionosphere monitoring application based on data from our network of more than 100 GNSS ground receivers, which are distributed over the Norwegian mainland and islands, covering the region from 20°W to 30°E and 55°N to 80°N.

Both the real-time and the archived results are available through a publicly available website. Here we present the website itself and its various data products. Examples are given for different ionospheric conditions to show the use of each data product. Current data products include VTEC, GIVE and ROTI maps (2-dimensional; longitude and latitude), and time series of ROTI for selected regions.

Long-term Fluctuations of Geomagnetic Field as prognostic Parameter of Solar Flare Activities

Sheiner, Olga; Smirnova, Anna; Snegirev, Sergey
Radiophysical Research Institute

The paper analyzes the variations of geomagnetic activity in order to create the foundations of the method of prediction the solar flare activity on the base of ground observations. There is shown that the closer to the start of proton flare the bigger amplitude of long-period (T>20 min) oscillation power of the horizontal component of the geomagnetic field and X-ray emission. We examined the differences in the behavior of long-term oscillation power of geomagnetic field observed by stations of different latitudes. It is compared the prediction quality using different approach to the choice of prognostic parameters. An algorithm for prediction of geoeffective solar flares is presented. The algorithm is checked on the base of the actual geomagnetic data.

Forecast of Total Electron Content over Europe for disturbed ionospheric Conditions

Berdermann, Jens; Borries, Claudia; Jakowski, Norbert
German Aerospace Center, DLR

A general picture of the occurrence of ionospheric storms as function of local time, season and location is known from numerous studies over the past 50 years. Nevertheless, it is not yet possible to say how the ionosphere will actually respond to a given space weather event because the measurements of the onset time, location of maximum perturbation, amplitude and type of storm (positive or negative) deviate much from the climatology. However, statistical analyses of numerous storm events observed in the Total Electron Content (TEC) since 1995 enable to estimate and predict a most probable upcoming perturbed TEC over Europe based on ACE observations and forecasts of geomagnetic activity. A first approach will be presented in this paper. The forecast of perturbed TEC is part of the Forecast System Ionosphere build under the umbrella of the FP7 project AFFECTS (Advanced Forecast For Ensuring Communication Through Space). It aims to help users mitigating the impact on communication systems.

The research leading to these results has received funding from the European Commission's Seventh Framework Programme (FP7/2007-2013) under the grant agreement no 263506.

Response of the Earth's Ionosphere to CMES Events

Sheiner, Olga; Fridman, Vladimir; Rakhlin, Aleksandr
Radiophysical Research Institute

The influence of solar processes on the state of near-earth space is constantly the object of serious study. First of all the solar radiation effect the parameters of the ionosphere and ionizing processes in it. The basic level indicator of the ionized particles is the critical frequency of the reflection of radio signal during sounding of ionosphere f_0F2.

The proposed study is based on the data of regular observations of critical frequency f_0F2 during the cycle of solar activity (1975-1986).

The authors proposed the procedure of the detection of influence of CMEs on the differential parameters of the upper ionosphere as more sensitive in comparison with the traditional methods.

In the report the need of developing the original procedures for the conducting the real time experimental studies of the revealed effects for the purpose of their subsequent model explanation is shown.

Forecast System Ionosphere: a new System for predicting space weather Effects in Europe

*Berdermann, Jens[1]; AFFECTS consortium, *[2]*
*[1]German Aerospace Center, DLR; [2]**

A Forecast System Ionosphere (FSI) is developed as part of the FP7 AFFECTS project (Advanced Forecast For Ensuring Communication Through Space*, http://www.affects-fp7.eu/), lead by University Goettingen. It is intended to help European citizens mitigating the impact of space weather events on its communications systems. For this purpose the FSI will operationally provide a prediction of space weather related geomagnetic and ionospheric perturbations for Europe. Solar observations and measurements are used for forecasting of geomagnetic activity and Total Electron Content (TEC). Additionally, high latitude geomagnetic monitoring and early warning for GNSS users is incorporated in the FSI. The FSI is developed as a subsystem of the SWACI service (http://swaciweb.dlr.de/), running at the DLR in Neustrelitz, using its approved system components. AFFECTS partners are contributing to the FSI either by provision of data or by delivering processing modules. This presentation will present the layout and system architecture of the FSI, describing the data input, processing, checking, archiving and output of the FSI. The actual status of work and the output of currently running processors will be demonstrated.

*) The AFFECTS consortium partners are University Goettingen, Royal Observatory of Belgium, National Academy of Sciences and National Space Agency of Ukraine, Fraunhofer IPM, University of Tromso, German Aeropace Center, Astrium GmbH and Space Weather Prediction Center of NOAA.

The research leading to these results has received funding from the European Commission's Seventh Framework Programme (FP7/2007-2013) under the grant agreement no 263506.

Monitoring, Analyzing and Assessing Radiation Belt Loss and Energization

Daglis, Ioannis A.[1]; Bourdarie, Sebastien[2]; Khotyaintsev, Yuri[3]; Santolik, Ondrej[4]; Horne, Richard[5]; Mann, Ian[6]; Turner, Drew[7]; Anastasiadis, Anastasios[1]; Angelopoulos, Vassilis[7]; Balasis, Georgios[1]; Chatzichristou, Eleni[1]; Cully, Chris[3]; Georgiou, Marina[1]; Glauert, Sarah[5]; Grison, Benjamin[4]; Kolmasova, Ivana[4]; Lazaro, Didier[2]; Macusova, Eva[4]; Maget, Vincent[2]; Papadimitriou, Constantinos[1]; Ropokis, Georgios[1]; Sandberg, Ingmar[1]; Usanova, Maria[6]
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We present the concept, objectives and expected impact of the MAARBLE (Monitoring, Analyzing and Assessing Radiation Belt Loss and Energization) project, which is being implemented by a consortium of seven institutions (five European, one Canadian and one US) with support from the European Community's Seventh Framework Programme.

The MAARBLE project employs multi-spacecraft monitoring of the geospace environment, complemented by ground-based monitoring, in order to analyze and assess the physical mechanisms leading to radiation belt particle energization and loss. Particular attention is paid to the role of ULF/VLF waves. A database containing properties of the waves is being created and will be made available to the scientific community. Based on the wave database, a statistical model of the wave activity dependent on the level of geomagnetic activity, solar wind forcing, and magnetospheric region will be developed.

Furthermore, we will incorporate multi-spacecraft particle measurements into data assimilation tools, aiming at a new understanding of the causal relationships between ULF/VLF waves and radiation belt dynamics. Data assimilation techniques have been proven to be a valuable tool in the field of radiation belts, able to guide 'the best' estimate of the state of a complex system.

NEMO: Near real time Dimming and EIT wave Detection on SDO/AIA

Kraaikamp, Emil; Verbeeck, Cis; Podladchikova, Olena
Royal Observatory of Belgium

Dimmings and EIT waves have been observed routinely in EUV images since 1996. They are closely associated with coronal mass ejections (CMEs), and therefore provide useful information for early space weather alerts. On the one hand, automatic detection and characterization of dimmings and EIT waves can be used to gain better understanding of the underlying physical mechanisms. On the other hand, every dimming and EIT wave provides extra information on the associated front side CME, yielding improved estimates of the geo-effectiveness and arrival time of the CME.

The Novel EIT wave Machine Observation code (NEMO) was initially developed to automatically detect and analyze EIT waves and dimmings using images provided by the SOHO Extreme-ultraviolet Imaging Telescope (SOHO/EIT). In the context of the Early Warning System of the AFFECTS FP7 project, the algorithm is currently being adapted at the Royal Observatory of Belgium to run in near real time on Solar Dynamics Observatory/Atmospheric Imaging Assembly (SDO/AIA) data.

In this talk we present an overview of the initial NEMO results on SDO/AIA and sketch an outline of the near real time detection system.

Key thermal plasma measurement Requirements for space weather Science in geosynchronous Orbit

Lavraud, B.[1]; Payan, Denis[2]; IRAP/CNES, Team[3]
[1]IRAP/CNRS/Université de Toulouse; [2]CNES; [3]IRAP/CNES

This presentation will highlight the key thermal (~0 - 40 keV) space plasma measurements that are required for enhanced space weather scince capabilities in geosynchronous orbit. It will focus in particular on needs related to time resolution, energy range, fields-of-view and data products and quality. These are then discussed in terms of instrumental designs that would provide such capabilities with minimum resources.

The Wideband Ionospheric Sounder Cubesat Experiment (WISCER)

Angling, Matthew[1]; Harkness, Patrick[2]; Drysdale, Tim[2]
[1]Poynting Institute, University of Birmingham; [2]University of Glasgow

This paper describes a preliminary design study to assess the possibility of flying a wideband ionospheric sounder cubesat experiment (WISCER). WISCER comprises a wideband (~100 MHz) beacon on a low cost cubesat designed to measure and evaluate the ionospheric channel in anticipation of the development of operational low frequency (i.e. around 450MHz) SAR systems.

There are considerable design challenges to be overcome in order to develop space based foliage penetrating (FOPEN) synthetic aperture radar (SAR) systems. One area of uncertainty is the impact of the ionosphere on the wideband radar signal, since the ionosphere is often the dominant degrading factor in these sorts of systems. The ionosphere controls the orbit choice, the selection of the transmitted waveforms and integration times, together with signal and image post-processing. The WISCER wideband beacon will only be operated over 2 equatorial receive stations and only during the main scintillation period (i.e. post-sunset, pre-midnight). The main receiver site is assumed to be Ascension Island and a secondary receiver site on Kwajalein Atoll (Marshall Islands) has also been considered. It is assumed that WISCER will operate for a minimum of nominally one year.

The design approach has been conservative: a high level of sub-system integration has not been assumed; off-the-shelf components and sub-systems have been considered for use wherever possible; the power budget has been developed on the basis of using both a prime and secondary ground station; and the use of a class A amplifier has been assumed. Even with these constraints the preliminary mass, volume and power budgets are achievable and there remains scope for optimisation.

The antenna remains a challenging area of the WISCER design. However, two candidate antennas have been identified. They exploit different electrical and mechanical designs and therefore provide some mitigation of development risks.

Some level of thermal control will be required during the operation of the sounder. A large amount of waste heat will be generated and it is likely that it will not be possible to remove this quickly enough from the satellite to achieve thermal equilibrium. Consequently some form of thermal storage will be required.

The Importance of Space Weather Awareness for Atmospheric Research after the Nuclear Incident in Fukushima

Santen, Nicole; Meier, Matthias; Matthiae, Daniel; Reitz, Guenther
German Aerospace Center

Space Weather Awareness is a crucial factor in the field of airborne radiation monitoring since solar radiation storms can significantly affect measurement results. For instance, a Solar Particle Event (SPE) can lead to an additional contribution to the radiation exposure of aircrew at aviation altitudes, which is generated by interactions of primary high-energetic particles of cosmic origin with atoms of the Earth's atmosphere.

The poster presents a case study of a measuring flight performed by the German Aerospace Center on 23rd March 2011, twelve days after the nuclear disaster of Fukushima, where large amounts of radioactive isotopes were released and spread across the entire globe. The flight aimed at gaining information about and samples from the radioactively unpolluted atmosphere at aviation altitudes in Germany. Radiation protection of aircrew and scientists required online-monitoring of the dose rate aboard the research aircraft in order to detect potential elevated airborne radioactivity and prevent the aircraft from contamination.

The fact that two days before the measuring flight NOAA had issued an alert due to a solar radiation storm, which indicated the possibility of an event that could lead to increased dose rates at aviation altitudes as well, required the permanent observation of the space weather situation in order to attribute a possible additional contribution to either a space weather event or the nuclear accident.

Recent Developments in the Radiation Belt Models used for SPACECAST Forecasts

Glauert, Sarah A[1]; Horne, Richard B[1]; Meredith, Nigel P[1]; Boscher, Daniel[2]; Maget, Vincent[2]; Heynderickx, Daniel[3]
[1]British Antarctic Survey; [2]ONERA; [3]DHC Consultancy

The population of relativistic electrons in the radiation belts is highly dynamic. Since these electrons can be hazardous to both spacecraft and humans the prediction of the electron flux throughout the radiation belts is an active area of research. The EU-fp7 project SPACECAST has been providing forecasts of the high energy electron flux using physics-based models since 1st March 2012 and is also undertaking research to improve the forecasts.

This research has produced a better model for chorus diffusion, a method for including the location of the last closed drift shell in the model and improved starting condition for the model runs. We present results illustrating the effect of these improvements on the forecasts produced with radiation belt models, and evaluate the improvements using comparisons with data and skill scores.

The STAFF Viewer: all space weather Timelines brought together in one powerful Web Application

Verbeeck, Cis[1]; Malisse, Vincent[1]; Bourgoignie, Bram[1]; Mampaey, Benjamin[1]; Delouille, Veronique[1]; the AFFECTS team, [2]
[1]Royal Observatory of Belgium; [2]

The Solar Timelines Viewer for AFFECTS (STAFF) is a dynamical online viewer that provides a whole range of timelines related to solar activity and space weather. It is currently being developed at the Royal Observatory of Belgium (ROB) as part of the FP7 project AFFECTS (Advanced Forecast For Ensuring Communications Through Space).

STAFF has been designed to allow the user to view and compare timelines from different data sources in any time interval, ranging from real time to the full archive of past data. STAFF is a web-based application based on JSP, HTML, CSS and javascripts and is built on top of a PostGreSql database.

Since it is tailored to space weather operations, STAFF provides easy and dynamical access to real time space weather timelines such as GOES X-ray curves, ACE data and geomagnetic indices. It also serves solar activity timelines such as the International Sunspot Number and the F10.7 radio flux. Furthermore, STAFF features some brand new proxies extracted automatically from coronal EUV images (AIA, SWAP, EIT), like the total flux observed in the telescope passband, active region area, and total EUV intensity within active regions. We present an overview of the STAFF viewer, its ease of use and some of its timelines.

Assessment of geomagnetic proxies characterizing Thermosphere Density Forcing during intense geomagnetic Storms

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A new version of the semi-empirical DTM (Drag Temperature Model) thermosphere model is developed in the frame of the FP7 European program ATMOP (Advanced Thermosphere Modelling for Orbit Prediction). In the currently used semi-empirical density models (DTM2009, MSIS, JB2008) the geomagnetic forcing is characterized using geomagnetic indices derived from ground based measurement: am indices, ap indices and Dst index respectively. In this work, we test new geomagnetic indices, with a better representation of the geomagnetic activity using Magnetic Local Time (MLT) sectors, or an improved time resolution. This test is carried out using total mass density derived from acceleration measurements onboard CHAMP and GRACE satellite, in the 370-490 km altitude range. We consider intense geomagnetic storms (max of am>120 nT) that occurred between August 2001 and December 2010. Density variations are organized according to local time and geomagnetic coordinates to assess the performance of the proxies that we consider in this study: K-derived 3-hour planetary (am) and MLT sector indices, new planetary and MLT sector rms based α indices

Properties of coronal Holes as Sources of Geoeffectiveness

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Coronal holes are key features to understand geoeffective events involving high speed streams. The properties of the coronal holes are analysed, such area and magnetic field, through AIA 193A images and HMI longitudinal magnetograms. We study the statistical properties of the magnetic field of the coronal holes. Interacting active regions in the surroundings of the coronal holes, where CMEs are ejected, are also considered for study.

Whistlers Detected by the Belgian VLF Antenna of Humain

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2Whistlers are VLF (3-30 kHz) emissions initiated by lightning, propagating along magnetic field lines, observed on ground and in space. Whistler wave analysis is an effective tool for studying the plasmasphere. Whistlers acquire particular frequency-time characteristics while they propagate through the magnetospheric plasma, and in particular through the plasmasphere. Their propagation time depends on the plasma density along their propagation paths. It is possible to derive the plasmaspheric electron density distribution from these propagation times.

We therefore have started a project to detect whistlers with VLF measurements. A VLF antenna has been installed in early 2011 in Humain, Belgium (50.11°N, 5.15°E). The VLF antenna is made of two perpendicular magnetic loops, oriented North-South and East-West, and with an area of approximately 50 m^2 each. This antenna is part of AWDAnet, the Automatic Whistler Detector and Analyzer system's network. This network covers low, mid and high magnetic latitudes, including conjugate locations. We use the AWDA system to retrieve automatically electron density profiles from whistler measurements made in Belgium. In this poster, the first results of whistler occurrence are shown.

Study of ionospheric parameters Variability together with neutral atmospheric Parameters

Koucka Knizova, Petra; Kouba, Daniel; Mosna, Zbysek
IAP ASCR

System neutral atmosphere-ionosphere shows high variability in a broad period range. Wave-like oscilations covering gravity, tidal and planetary wave domains are subject of the contribution. Time series of temperature, neutral wind, electron concentration describe temporal variability of the neutral atmosphere-ionosphere system. Within wave-like wave bursts detected in time series of ionospheric and/or neutral atmospheric parameters we locate common coherent structures that significantly contribute to the atmospheric regions coupling.

Kinetic Modeling and Simulations of tangential Discontinuities

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The study of space plasma discontinuity regions and their associated current sheets plays a key role in understanding the physical mechanisms responsible for the transfer of mass and energy in space plasmas. The propagation of the solar wind discontinuities and their interaction with the terrestrial magnetosphere is a key aspect of space weather. In this paper we investigate the kinetic structure of a tangential discontinuity using particle-in-cell simulations and comparison with kinetic models. Maxwell's equations are used to compute the self-consistent electromagnetic field on a one-dimensional spatial grid having a step size of the order of Debye length. The simulation domain is divided into two regions filled with two different plasma populations. The initial magnetic field is uniform inside the simulation domain. Spatial and temporal variations of the plasma parameters and electromagnetic field have been analyzed and discussed. Numerical results obtained confirm the formation of a tangential discontinuity at the boundary between two magnetized plasmas having different macroscopic properties. Both ion- and electron-dominated layers are evidenced. The transition profiles obtained using particle-in-cell simulations are in good agreement with the results given by theoretical kinetic models and shows the respective role of electrons and ions to establish the transition profile, the dominant current carrier and the spatial scale of the discontinuity. The particle-in-cell simulations provide additional details about the stability of the transition layer that complement the quasi-stationary kinetic modeling.

Improving solar wind propagation Delay Estimation using Wavelet Denoising

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We present a statistical study of the role of denoising on the propagation accuracy of solar wind discontinuities. The term discontinuity denotes here rapid changes in the direction of the Interplanetary Magnetic Field (IMF). A number of 151 discontinuities are propagated based on different models from a solar wind monitor, the Advanced Composition Explorer (ACE) spacecraft, located at the L1 libration point, in the upstream solar wind, to a target near the Earth's magnetopause, the Cluster quartet of spacecraft. The predicted propagation times are compared with the observed ones to obtain a quantitative measure of the method's accuracy. We compare different methods to estimate the normal of discontinuities: the Cross Product method (CP), the Minimum Variance Analysis of the magnetic field (MVAB) and the Constrained Minimum Variance Analysis of the magnetic field, referred to in the literature as MVAB0 where the predicted normal is constrained to be perpendicular to the mean magnetic field. Estimations of the normal using single spacecraft methods, especially the minimum variance based methods, are known to be sensitive to small-scale fluctuations and wave activity superposed on the discontinuity. Instead of using the usual methods of frequency filtering, which smear out the discontinuities and reduce the number of data points, we use wavelet denoising to remove this "noise". The wavelet denoising methods are especially suited for removing low-amplitude, high-frequency noise, while leaving unchanged the high-amplitude, low-frequency parts of the signal and also preserving the time resolution. The results show that by fine tuning the model and wavelet denoising parameters we can improve significantly the prediction accuracy. We also found that, even for well defined discontinuities, the model and denoising parameters have to be adapted to every event in order to obtain accurate propagation delays. In other words, we do not find any fixed set of parameters for which to obtain an accurate propagation delay for most of the discontinuities in our data set.

Analysis of Digisonde drift measurements Quality

Kouba, Daniel; Koucka Knizova, Petra; Boska, Josef
IAP ASCR

Ionosondes underwent significant improvements since their invention in 1924. At the beginning, ionospheric sounders measured only vertical profile of electron concentration. Contemporary modern digital ionosondes usually provide ionospheric drift measurement as a part of the routine monitoring in addition to the classical vertical ionospheric sounding (ionogram measurement). Ionospheric plasma motion monitoring has a large potential to improve our understanding of an ionospheric dynamics. However the measurement quality is highly variable. In the paper we deal with conditions and assumptions necessary for the correct drift velocity estimation, particularly with differences in measurements for E and F region. Correct and accurate drift velocity estimation requires recording of a sufficient number of reflection points during the measurement. We discuss how to obtain good quality drift data and how to estimate data quality. Large number of recorded drift measurements are eliminated from further use for drift velocity estimation due to low number of detected reflection points. Our analysis done for a large data set strongly supports the idea that even low number of recorded reflection points may indicate an expressive horizontal stratification of the ionosphere. For our study we used drift data collected in 2006 from a mid-latitude station Pruhonice. Data were collected during a period of low geomagnetic and solar activity. We show statistical properties of drift velocity components for both E and F region. We illustrate the influence of geomagnetic activity on drift velocities on maximal daily value of F region horizontal component (geomagnetic activity is represented by Kp). We also show statistics for poor-quality data associated with horizontal stratification of ionosphere.

The SEPEM statistical solar energetic particle Model away from 1 AU

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Present statistical models for the description of solar energetic particle (SEP) radiation in the inner heliosphere extrapolate fluences and peak intensities measured at 1 AU by using simple scaling laws on the heliocentric radial distance. In the Solar Energetic Particle Environment Modelling (SEPEM) project we have developed a statistical SEP model that makes use of the results of a shock-and-particle propagation physics based model to estimate peak intensities and fluences from 0.2 to 1.6 AU. We used this physics based model to derive the radial variation of the peak intensity and fluence for six SEP event case studies.

The SEPEM statistical model is based on 1 AU cleaned data from 1973 to 2009. We have determined the solar origin of the 204 SEP events (compound and isolated) of the SEPEM Reference Event List that occurred between January 1988 and December 2006. We have analyzed their intensity and maximum energy attained. Then, we have classified these events into the six different types in order to assign to them a radial dependence for the peak intensity and the fluence.

We discuss here the resulting event spectra and the application of this model to estimate the fluence over an interplanetary mission travelling to the inner heliosphere like the Solar Orbiter. We compare these results with those obtained for a mission at 1 AU of the same duration, and with those obtained by applying the current ECSS guidelines for distances away from 1 AU. We also comment on possible improvements to the physical based model that will be studied in the scope of the FP7 SPACECAST project. The statistical model and the method we present here are being implemented on the SEPEM server.

What do causal Relations between flare Irradiances at various Wavelengths tell us?

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Solar flares, the most energetic events in the solar system, play an important role in space weather. X-class flares can lead to dramatical increases in the extreme ultraviolet (EUV) and soft X-ray (XUV) emissions, and also in longer wavelengths. Many of the fundamental processes involved in the flare onset and evolution, however, are still partly understood; this impacts the evaluation of the geoeffectiveness of such flares. Among these is the ordering of the acceleration processes during the flaring event. Here we consider an information-theoretic approach that is based on the Granger causality to investigate the correlation between the evolution of the solar spectral irradiance as observed in different wavelengths from the XUV and EUV, and using various instruments (GOES, SDO/EVE, PROBA2/LYRA). Using this approach we reveal in the energy flows between different solar atmospheric layers. These results can be used as clues for successful flare modeling in space weather prediction and nowcast operational services.

Space weather Investigation with PICASSO

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PICASSO is a 3U cubesat project of the Belgian Institute for Space Aeronomy and the Royal Observatory of Belgium. It is planned to fly on the QB50 precursor mission in a quasi-polar orbit at about 500 km altitude and thus the expected orbital lifetime is at least two years. The payload of PICASSO includes three independent scientific instruments:
VISION, a visible and near-infrared hyper-spectral imager, m-NLP, a multi-needle Langmuir probe and ìBOS, a micro-bolometer oscillation system.
Given the high inclination, the multi-needle Langmuir probe developed by the University of Oslo will allow a global monitoring of the ionospheric electron density. Therefore, PICASSO will provide opportunities to study relevant space weather processes such as the ionosphere-plasmasphere coupling, the dynamics of the subauroral ionosphere and related magnetospheric processes, the aurora and the polar cap arcs, the ionospheric electrodynamics via coordinated observations with EISCAT's heating radar and the turbulent ionospheric processes.
We provide a description of the nano-satellite PICASSO with an emphasis on the multi-needle Langmuir probe and its applications for space weather studies.

Vulnerability of the Spanish pPwer Network to space weather Disturbances from an historical Perspective

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University of Alcala - Space Research Group - Space Weather

Geomagnetically induced currents (GICs) constitute the ground end of the complicated space weather chain originating from the Sun. In power grids, GICs can lead to half-cycle saturation of power transformers and generate significant amounts of odd and even harmonic distortions in the system current and voltages. As a result, protection and control devices are led to incorrect or undesired operation unintentionally isolating equipment at time when critical support to the system is needed. In order to know the vulnerability of the Spanish power network to space weather disturbances, historical records of impacts and actions reported by grid operators in isolating components, such as transmission lines, transformers, capacitor banks in the REE power network, have been analyzed and compared with different geomagnetic indices and local magnetic field measurements. This presentation shows the results of this study.

Long Term modulation Algorithm for Solar Cycle Maximum R12 Index

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R12 is the most widely used index for Ionospheric predictions, it is the twelve-month smoothed relative sunspot number (SSN) calculated from the international solar index Ri. It is known the great difficulty in predicting the maximum level of R12 for the next solar cycle using different methods, even when the cycle has begun and its rate of change is really in progress. As Presnel W. D.(2008) shows, more than 50 predictions with big differences in amplitude (from 40 to 185) were found for solar cycle 24, which was the 3rd cycle predicted by an international commision.

The international interest to improve the predictions for R12 maximum is due to the well known practical use in satellite signal transmission risks and in HF radio communications, the Space Weather Centers provide this service. Hathaway D. H., Wilson and Reichmann (1999) showed different methods used for predictions of solar maximum based on statistical or precursor techniques and mathematical function, and presented a combined method for Solar Cycle activity forecast of cycle 23.

It is valuable to compare predictions with data, in particular the shape of evolution of the maximum which is very variable. In this report we first compare yearly and smooth SSN data since 1700, to present a method to simulate yearly SSN data as a signal transmited in radio communications, with a carrier of 22 year period modulated by long periods of 33, 55, and 110 years, observed in the maxima and minima of the 11 year solar cycles. We understand that such periodic characteristics are related to physical phenomenon as say flux-transport dynamo-based tool presented by Dikpati M, G. de Toma and P.A. Gilman (2006). We verify periods using FFT analysis and compare with previous studies. The use of amplitudes and phase shifts properly chosen, really improve the results. Despite the method shows unstable fitness, it follows the shape of evolution of the maximum of solar cycles, except in the minimum of the 110 year period. As we are just near one of such minimum, the method used in this work let us expect similar amplitudes to those observed about 1900 for the next cycles 24-25 , that is, R12 around (50-100).

Space Weather and Ultraviolet Solar Variability Microsatellite Mission: a European Space Weather Dedicated Mission

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We present the scientific objectives and model payload of the Space Weather and Ultraviolet Solar Variability Microsatellite Mission (SWUSV), as proposed to CNES and ESA (Small-size Mission) this year. Mission is designed around an innovative far ultraviolet full disk imaging telescope, narrow bands ultraviolet filter radiometers and a simultaneous Earth Radiative budget ensemble for new achievements and key challenges for further advances. In particular, the ambitions of this new program are:
- The Space Weather including the prediction and detection of major eruptions and CMEs (Lyman-alpha and Hertzberg continuum, 200-220 nm, imaging);
- Solar forcing/infulence on the climate through radiation and their interactions with the local stratosphere (UV spectral irradiance from 180 to 400 nm by bands of 20 nm, Lyman-Alpha and CN bandhead, 385-390 nm);
- Simultaneous radiative budget of the Earth, UV to IR, with an accuracy better than 1% in differential.
The mission builds upon the success and skills of two previous European Space Weather related missions: PICARD/CNES and PROBA-2/ESA. A CNES Research and Technology program has been started on New Ultraviolet Telescopes key technologies to guarantee the mission success.

l1 testbed Analysis of CMEs

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ACE L1 solar wind data are analyzed for CME events that have caused medium to major geomagnetic storms at times after the twin STEREO spacecraft reached a sufficient separation angle with respect to the Sun-Earth line to provide dedicated tracking of CMEs from Sun to Earth. The CME coronal parameters derived from analysis based on the remote sensing observations of the STEREO/SECCHI imagers are extrapolated to the inner boundary of the WSA-Enlil code to model the CME evolution to L1. The model results are compared with those derived from analysis of the ACE in situ ICME parameters and are used for calibration of the WSA-Enlil code in a testbed manner. This study presents the basic concepts of the testbed studies and first results.

Near real-time Parametrization of CMEs through multipoint Observations

Hesemann, Jonas[1]; Bosman, Eckhard[1]; Bothmer, Volker[1]; Venzmer, Malte[1]; Pizzo, Vic[2]; Viereck, Rodney[2]; Millward, George[3]; Biesecker, Doug[2]; de Koning, Curt[3]
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The 3-View CME Analysis Tool ("CAT") technique developed at the Space Weather Prediction Center Boulder, CO, is a coronal analysis tool through which the topology, direction of propagation and speed of CMEs can be analyzed in near real-time from multipoint observations provided by the STEREO and SOHO coronagraphs. In this study we apply the CAT technique to a set of bright CMEs viewed from different angles that had been already analyzed through the GCS (Graduated Cylindrical Shell) model. We present results of the comparison of the different analysis techniques for the set of CMEs studied and summarize implications for their operational use.

Solar Energetic Particle Research and Space Weather Hazards' Forecasting: COMESEP Project Activities at NOA

Malandraki, Olga[1]; Tylka, Allan, J.[2]; Ng, Chee, K.[3]; Marsden, Richard, G.[4]; Tranquille, Cecil[4]; Patterson, Douglas[5]; Armstrong, Thomas, P.[5]; Lanzerotti, Louis, J.[6]; Patsou, Ioanna[1]; Tziotziou, Kostas[1]; Lygeros, Nikos[1]; Papaioannou, Athanasios[1]; Crosby, Norma[7]

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Basic research on Solar Energetic Particles (SEPs) carried out at the Institute of Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS) of the National Observatory of Athens (NOA) within the framework of the COMESEP project is presented in this work. Two SEP events taking place in December and August 2001 were identified as having an initial ratio of Fe/O > 0.8 and were selected for an investigation into SEP sources, and acceleration processes operating on SEPs in terms of solar flares, ICMEs and their associated shocks. Ulysses/COSPIN/LET and WIND/EPACT/LEMT data were used for these events. During the two events transient Fe/O enhancements were initially observed at both WIND and Ulysses although one or both spacecraft were not 'well-connected' to the flare. The observations demonstrate that the initial Fe/O enhancements can be better understood as a transport effect driven by the different mass-to-charge ratios of Fe and O, rather than a direct flare component. These observations also provide a potential constraint on models in which SEPs reach high heliolatitudes by cross-field diffusion. Furthermore, we have carried out the first detailed examination and comparison of elemental spectra and composition in the late decay phase of the events in the so-called 'reservoir' regions, between spacecraft widely separated in latitude, as well as in longitude and radial distance in the Heliosphere. Implications of the observations for models of SEP transport are also discussed. Furthermore, the study of the impact of the large-scale structure of the Interplanetary Magnetic Field (IMF) on the SEP profiles and its Space Weather implications will be presented, based on the examination of the Pitch Angle Distributions (PADs) of non-relativistic electrons and the inference of the presence of a reflecting boundary of SEPs, resulting to the enhancement of the duration of high-energy proton intensities, causing the so-called "reservoir" effect. These activities will provide the basis for future solar missions such as Solar Orbiter, in which IAARAS/NOA participates as a Co-Investigator (EPD instrument). The above research is carried out within the framework of the COMESEP project in which IAASARS/NOA is currently strongly involved. The COMESEP project is a collaborative project funded by the Seventh Framework Programme of the European Union which sets out to develop tools for forecasting Solar Energetic Particle (SEP) radiation storms and geomagnetic storms. It is foreseen that these forecasting tools will be incorporated into an automated operational European Space Weather Alert system.

The research leading to these results has received funding from the European Commission FP7 Project COMESEP (263252).and has also been supported by NASA under grants NNH09AK79I and NNX09AU98G (AJT).

Ionospheric Behaviour over Europe driven by moderate geomagnetic Storms in 2012

Vryonides, Photos

Frederick University

During the first half of the current year (2012) as we were progressing towards the rising phase of solar cycle 24, a certain number of geomagnetic storms of moderate intensity occurred due to coronal mass ejections and solar wind streams affecting Earth's magnetic field. These storms occurred throughout the year. In this paper, we present the ionospheric response during these storms using ionosonde and GPS data over Europe. Variation of ionospheric characteristics is studied in correlation with geomagnetic indices to reveal temporal progression during these events.

Evolution of coronal Structures associated with plasma Outflows at rising solar Activity from SWAP and EIS Observations

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[1]P.N. Lebedev Physical Institute; [2]UCL/MSSL; [3]European Space Agency& Royal Observatory of Belgium

The solar inner corona below 2 Rsun is an important region of restructuring of magnetic field and formation of the solar wind streams. The SWAP telescope has advantages to study the corona in comparison with similar instruments like EIT/SOHO and AIA/SDO, because it's spectral band (174 A) is the most sensitive to the coronal EUV emission at temperature ~ 1 MK and it can be off-pointed to enlarge the field of view in the desired direction. Recently it was shown that large-scale coronal ray-like structures observed by SWAP may be associated with outward plasma flows from ARs detected by Hinode/EIS in the Doppler shifted Fe ion lines. We report on the results of the coordinated SWAP-EIS study of

evolution of the coronal structures associated with plasma outflows from ARs 11112, 11176 and 11309 in the Carrington rotations CR 2102, 2108 and 2115 (October 2010, March-April and October 2011). The movies showing the off-limb corona observed by SWAP in these rotations as a function of time and height are presented. In the course of rising solar activity the extended coronal structures detected by SWAP above the ARs changed from nearly radial or super-radial rays emerging from single AR in CR 2102 to parts of helmet-like structures in the streamer's bases in CR 2108 and CR 2115. In all ARs EIS detected localized outflows, in two last cases the outflow regions were tracked during their rotation from the eastern limb to te western limb showing that most of the time the outflux density remained nearly constant. The outflows and coronal structures were correlated with open magnetic field lines given by the PFSS extrapolation, white-light streamers and the ACE solar wind data projected to the source surface.

Background solar wind Modeling and its Relevance for the Propagation of interplanetary coronal mass Ejections

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The background solar wind characteristic is a key ingredient for the study of CME propagation in interplanetary (IP) space, in particular for the prediction of ICME arrival time and arrival speed at Earth. Since in-situ measurements of the background solar wind are only available at 1 AU, one has to rely on heliospheric models and/or empirical relationships to derive the solar wind distribution in IP space. We tested different empirical and MHD models to predict the solar wind characteristics at 1 AU, including ENLIL/MAS, ENLIL/WSA, and an empirical model based on the size and location of coronal holes on the Sun. The modeled solar wind parameters were compared with in-situ measurements from ACE and Wind at 1 AU for two years of low ICME activity during the last solar minimum. We found, that the general structure of the background solar wind is well reproduced by the models, with the best results being obtained for the solar wind speed. However, the predicted arrival times of high speed solar wind streams have typical uncertainties of the order of 1 day. The ICME propagation in IP space is basically governed by two forces: the propelling Lorentz force and the drag force exerted by the ambient solar wind flow. We applied the derived background solar wind distribution to study the interplanetary propagation of selected coronal mass ejections which were tracked all the way from the Sun to 1 AU in remote-sensing observations of the Solar TErrestrial RElations Observatory (STEREO) Heliospheric Imagers and in-situ plasma and magnetic field measurements. This work has received funding from the European Commission FP7 Project COMESEP (263252).

Statistical Study of the solar wind Modification in the Earth's foreshock: THEMIS Observations

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In statistical study of the Earth's foreshock we use multi-point observations from the THEMIS-ARTEMIS mission and compare to WIND solar wind monitor with motivation to estimate different factors influencing evolution of solar wind. Most studies of the solar wind-magnetosphere interaction rely on L1 observations that are propagated toward the Earth assuming negligible evolution of upstream parameters along the solar wind path. But in fact there is most pronounced effect of a systematic deceleration of the average solar wind speed with a decreasing distance to the bow shock that is controlled by the level of magnetic field fluctuations and by the flux of reflected and accelerated particles in the foreshock region. We can conclude that the reflected particles not only excite the waves of large amplitudes but also modify mean values of quantities measured mainly in the foreshock but also in an un-perturbed solar wind.

Consistency of Path Lengths Traveled by Solar Electrons and Ions in Ground-Level Enhancement Events

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The highest energy (GeV and above) protons in the solar energetic particle (SEP) events may interact with the Earth's atmosphere to produce sufficient intensity of secondary particles that can be detected by neutron monitors at ground level, causing the ground level enhancement (GLE) event. Since high-energy protons represent "hard" radiation that is a significant hazard to astronauts and equipment in space, while secondary neutrons threaten passengers and crew of aircraft on polar routes, understanding where, when, and how the acceleration of these particles takes place is important in space weather forecasting. In view of a long-lasting divergence between the estimated path lengths travelled by solar electrons and ions from their release site near the Sun to the 1 AU observer, we have examined the divergence by using the Wind/3DP/SST electron and Wind/EPACT/LEMT ion data for the GLE events during the solar cycle 23. Assuming that the onset time of metric type II radio bursts is the solar release time of non-relativistic electrons, we have found that the deduced path length of low-energy (~ 27 keV) electrons is consistent with the ion path length deduced by Reames (2009) from the onset time analysis, indicating that SEPs in GLE events should be accelerated by the coronal mass ejection-driven shock waves. In addition, we have observed the increase of electron path lengths with increasing electron energies. The increasing rate is correlated with the pitch angle distribution (PAD) of peak electron intensities locally measured, with a higher rate corresponding to a broader PAD. The correlation indicates that the path length enhancement is due to the interplanetary scattering experienced by first arriving electrons.

The observed path length consistency implies that the magnetic flux tube, along which particles transport, could be stable during a time period of > 5 hours. Therefore, it is possible to use the electron observation at the event onset to predict the duration property of high-energy proton intensities during the later decay phase. The suggested prediction could be important in space weather forecasting.

Reames, D. V. 2009, ApJ, 693, 812
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Space-Weather Awareness and eHealth: The Cross Point

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The Space-Weather Awareness is usually focused at raising awareness of the potential impact of space weather on critical infrastructures in view of the growing risk of technological catastrophic events. The impact of Space-Weather on human health is either totally neglected or underestimated. At the same time, it is already accepted that a subset of the human population (10-15%) is a bona fide hypersensitive and predisposed to adverse health problems due to geomagnetic variations and that extremely high as well as extremely low values of geomagnetic activity seem to have adverse health effects. Knowing how and how much the space weather can influence the daily health status of people is of extreme practical importance.

The presentation is focused on space weather awareness, i.e. the cross point between space weather effects on human health and eHealth issues. It will outline what is necessary to be taken into consideration based on the achievements of the TeleSCoPE project (Telehealth Services Code of Practice for Europe) and how eHealth can contribute to space weather awareness for the benefits of citizens.

Early March 2012 X-Ray Flares: VLF Perspective, Observations and Modelling

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We present stable and continuous VLF observations of the remarkable sequence of early March 2012 (0306-09) C to X class solar X-ray flares, and flare induced D-region electron density enhancements, modelled on the ground of the respective VLF-GOES15 datasets. The majority of the prominent flares in the period 20120306-09 happened at early UT, therefore, the highly suitable, completely sunlit, long, low-noise, transmitter- receiver paths were chosen for their observation: i.e. from transmitters NPM/21.4 kHz (Hawai'i) and NWC/19.8 kHz (North West Cape, Australia) to receivers at Casey (66.28 S, 110.32 E) and at Scott Base (77.83 S, 166.66 E) in the Antarctic region.

To deduce D-region electron density enhancements induced by solar flares, we apply the N(t,h) model, based on the electron continuity equation for the globally electroneutral and diffusion free lower ionosphere. The transient ionization regime is described by the production rate $q(t)= kI(t)$, driven by the dominant X-ray flux $I(t)$ and the electron effective recombination coefficient α. The time delay by which the amplitude and phase extrema lag behind the flare flux maximum is a key observed input parameter which relates two characteristic electron density enhancements: the maximum value and value at the maximum flux. The proximity of these two N values (time delay is found to amount up to several minutes), sets a constraint for each particular flare, allowing the determination of either k or α, if one of them is known independently. For the relevant flare wavelength band 0.1-0.8 nm we have inferred the expression for the altitude variation of k from observed spectral data compiled by Allen (1965, Space, Sci. Rev. V.4, 91-122) and from the model calculations of $q(h)$ (Osepian et al. 2009 Ann. Geophys., V.27, 3713–3724).

The model output is the electron density time-height profile, the span of the time dependence being governed by the flare duration (from some 20 min to several hours), whereas the height range is set by the physical characteristics built in the model and pertaining to the region from 60 to 90 km. The results thus obtained, are validated by the independent and well-known Long Wavelength Propagation Capability (LWPC) code. For the offset of disturbed amplitude and phase enhancements, the values for the quiet day 20120228 preceding the flare period have been used. Good agreement between the two approaches (i.e. both predicting for 1X class flare enhancement of electron density at 60 km height of two orders of magnitude with respect to quiet day values) is taken as a starting point for studying the height - dependence of aeronomic parameters in flare conditions.

POPDAT- Problem-Oriented Processing and Database Creation for Ionosphere Exploration

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Earth's ionosphere plays a very important role in the solar-terrestrial processes. Its dynamics, that is an important element of the Space Weather, is strongly influenced by solar activity. The actual state of the ionosphere is described by set of various parameters, and its nowcasting and forecasting is rather complex. The exact monitoring of those parameters needs both the sophisticated data analysis and utilization of measurements performed by different missions. In that context POPDAT project is aimed at developing and deploying new methods of processing and representation of the ionosphere data received from the series of the completed ionospheric satellite missions. The output of the project is the Ionosphere Waves Service that will make third level data available for great number of scientists. It is expected that with its approach POPDAT will help to enhance our understanding of rich physical processes taking place in Earth's surroundings.

Modeling of GIC in the regional Power System for strong Geomagnetic Storms

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A new version of the program for calculation of geomagnetically induced currents (GIC) in power grids was developed in the Finnish Meteorological Institute within the EURISGIC project (European Risk from Geomagnetically Induced Currents). Successful validation of the model in 2012 makes it possible to estimate possible extreme values of GIC related with strong geomagnetic disturbances at former times. The geoelectric field was calculated using data from IMAGE magnetometer stations in North Europe and 1-D block models of the ground conductivity. Temporal evolution of GIC was estimated using the regional model of the power grid at NW of Russia. Calculated extreme values of GIC at selected transformer substations can be used for analyses of the impacts of strong geomagnetic storms on high-voltage systems.

Impacts of Faraday Rotation and ionospheric Scintillation on the ESA BIOMASS P-Band synthetic aperture Radar

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BIOMASS is a candidate Earth Explorer mission under consideration by the European Space Agency (ESA). It comprises a P-band (435 MHz) synthetic aperture radar (SAR) in a low earth orbit and its principal mission objectives are to measure forest biomass density and height with near-global coverage. Secondary objectives include imaging of sub-surface geology and ice sheets, and measurement of bare earth topography under dense vegetation. BIOMASS will measure the radar backscatter intensity in four polarization channels, HH, HV, VH and VV, each representing a combination of the transmitted and received linear polarizations. The biomass density will be determined using a Bayesian approach that combines a regression-based estimate from the polarimetric covariance matrix with an indirect estimate derived from forest height using allometric relations.

The ionosphere introduces a Faraday rotation (FR) to the plane of polarization, given by $\Omega = KB_{||}TEC/f^2$, where K is a constant, f is the radio frequency, $B_{||}$ is the component of the geomagnetic field along the ray path and TEC is the (slant) total electron content. If uncorrected, FR transfers backscattered energy between the four polarization channels, thus affecting the biomass densities inferred from the measurements. An accurate estimate of FR is also required for calibrating the system using dedicated calibration targets.

Several algorithms [1-4] have been proposed to estimate and correct FR in SAR images. However, the accuracy of the backscattering and covariance matrices derived from the measurements is limited by transmitter and receiver distortion (phase imbalance and cross-talk), additive noise (i.e. noise equivalent σ_0 (NESZ)) and, for some methods, errors in the independent estimate of FR, Ω_0, which is required to resolve a pi/2 ambiguity in the estimate of Ω (Ω_0 is derived from ionospheric models or GPS measurements of TEC, hence is affected by their accuracy). This paper quantifies the errors in FR correction for each algorithm by simulating SAR images of a forest scene with three levels of uniform biomass density. Images were produced with the ESA BIOMASS end-to-end radar simulator (BEES) [5] and corrupted with a large range of FR angles, cross-talk amplitudes and phases, NESZ and errors in the independent FR estimate. We conclude that with a suitable correction algorithm employing spatial averaging, FR may be corrected to within 0.5° for biomass densities between 50 and 350 t/ha, given NESZ of -24 dB and cross-talk of -24 dB, which are worse than the threshold values stipulated as BIOMASS system requirements.

The P-band BIOMASS radar would also be strongly susceptible to ionospheric scintillation - small-scale (< 20 km) fluctuations of the phase and amplitude of radar returns caused by scattering from ionospheric irregularities. This introduces sub-aperture scale fluctuations in the radar phase front, which corrupts the SAR impulse response function (IRF) and leads to coarser resolution, increased sidelobes, reduced main-lobe intensity and geometric shifts of the peak. Percentiles of these IRF metrics are determined using a climatological scintillation model for a range of conditions of solar and geomagnetic activity and for several BIOMASS SAR configurations employing single- and four-look strip-map modes of operation. Given a suitable choice of dawn-dusk orbit (with an ascending node between 0500 and 0740 local time) much of the strongest scintillation in the low-latitude post-sunset sector is avoided. The impacts of scintillation for forest regions are found to be negligible under all conditions except at high latitudes in the North American sector under high sunspot activity and during geomagnetic storms. Consequences for high-latitude ice monitoring are much more widespread.

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Visualisation Tool for Geomagnetically Induced Currents

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As part of the EU/FP7 project EURISGIC, a visualisation tool for geomagnetically induced currents have been created. This tool have been developed for the purpose of demonstrating GIC in the wide European power grid for a set of geomagnetic storms and artificial geoelectric field data.

Power grid data for Europe, consisting of substation coordinates, line- and transformer resistances, voltage levels etc, were collected and stored in a MySQL database. At present the database includes information of about 1800 transformer stations and 2400 high-voltage lines for more than 30 european countries.

The application consists of two main parts: a server-side application and a client-side web application. The power grid and GIC levels are visualised on an interactive map by the web-application, using Google Maps API and JavaScript code, that is available online at http://www.eurisgic.eu/. The GIC levels are calculated by Octave. The server-side application interact with the web-application and database and uses the JSON format for transmitting the data.

The tool is useful for demonstrating GIC but also as a test-platform for a stand-alone application aimed towards e.g. power companies, pipeline operators and universities.

Initiation Mechanisms for coronal mass Ejections without distinct coronal Signatures

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Solar eruptions are associated with a variety of phenomena that occur in the low corona before, during, and after the onset of eruption. These phenomena include changes in magnetic configuration, flows, solar flares, the formation of post-flare loop arcades, EUV waves, and coronal dimmings. However, not every eruption is associated with all -- or in some cases -- any of these phenomena. The presence or absence of such signatures can be linked to different theoretical models of eruptions to help establish the mechanisms by which the eruption is initiated and driven.

To identify these CMEs without low coronal signatures, we compare CMEs from the CACTus catalog to the output of SoFAST (Solar Flare Automated Search Tool) based on observations from SWAP/PROBA2. Using STEREO observations, we can exclude the back-sided CMEs. We use this list to characterize the general properties of events without low coronal signatures and, from this list, select a few eruptions to study in detail using both observations and numerical models.

Solar eruptions without clear on-disk or coronal signatures can have important implications on space weather, since many early warning signs for significant space weather activity are not present in these events. A better understanding of their initiation will significantly improve our ability to predict these space weather events.

Space Weather Applications and Requirements Over South Africa

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South African National Space Agency (SANSA)

The South African National Space Agency (SANSA) operates the Regional Warning Center (RWC) for Space Weather in Africa. The RWC is located within the Space Science Directorate of SANSA in Hermanus, South Africa. SANSA Space Science is a research facility for Space Science in South Africa, and operates a Space Weather Unit within its Research Group. Ground based geophysical data from distributed networks across Southern Africa and the South Atlantic are piped into the center along with satellite based data. The combination of ground and satellite based data is then used to produce information in a variety of formats depending on the needs. This paper will review the progress of the center for the past 2 years, present new measurements that are available for use by the center, and look at the applications that are currently being served within South Africa.

Comparison between coronal relative magnetic Helicity and photospheric Helicity Flux in an active Region

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We use full-disk line-of-sight magnetograms taken by MDI/SOHO from May 25, 2003, at 00:00 UT to May 28, 2000, at 22:23 UT in order to study the magnetic helicity budget in active region NOAA 10365 which produced several M and X GOES class flares and coronal mass ejections. In particular, we perform a comparison between the estimation of the relative magnetic helicity determined from linear force free field extrapolations and the accumulation of the magnetic helicity in the active region measured by means of the magnetic helicity flux propagating through the photosphere from the convection zone. We found a good general agreement between the results obtained with these two independent methods of the trend of the magnetic helicity variation within the active region. However, there are some differences, which we discuss, in terms of the limitations of the employed approximations and methods.

Development of complex and flare productive Sunspot Groups

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The morphology of sunspot groups is an important ingredient of flare- productivity, mixed polarities can more probably provide unstable states leading to eruptive events than bipolar configurations with unambiguous separation. The developments of these two types of configurations are compared on a large statistical material taken from the new SDD (SOHO/MDI-Debrecen sunspot Data) sunspot catalogue. The SDD contains the magnetic polarity data and allows a temporal resolution of 1.5 hours so high resolution time-profiles can be plotted for the entire active regions and any subsets. The time profiles will be compared with the recent theoretical curves of development and decay.

Statistical Analysis of solar energetic particles Events and related solar Activity

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The FP7 COMESEP (COronal Mass Ejections and Solar Energetic Particles: forecasting the space weather impact) project is developing tools for forecasting geomagnetic storms and solar energetic particle (SEP) radiation storms. Here we present preliminary results on a statistical analysis of SEP events and their parent solar activity during Solar Cycle 23. The work aims to identify correlations between solar events and SEP events relevant for space weather, as well as to quantify SEP event probabilities for use within the COMESEP alert system.

The data sample covers the SOHO era and is based on the SEPEM reference event list [http://dev.sepem.oma.be/]. Events are subdivided if separate enhancements are observed in higher energy channels as defined for the list of Cane et al (2010). Relationships are investigated between solar flare parameters such as X-ray intensity and heliographic location on the one hand, and the probability of occurrence and strength of energetic proton flux increases on the other hand. The same exercise is performed using the velocity and central position angle of coronal mass ejections to examine their SEP productiveness. Relationships between solar event characteristics and SEP event spectral indices and fluences are also studied, as well as enhancements in ion fluxes measured by the SIS instrument on board the ACE spacecraft during the same event periods. Comparisons between different statistical methods will also be shown.

This work has received funding from the European Commission FP7 Project COMESEP (263252).

Role of active region configuration Dynamics in flare Occurrence

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Structural developments of sunspot groups have been followed prior to solar flares in order to find criteria for flare occurrence.
The observational basis of the study was the detailed sunspot catalogue, the SDD (SOHO/MDI-Debrecen sunspot Data) covering the time interval of MDI operations, 1996-2011. The highest values of horizontal magnetic field gradients and the speed of their build-up have been mapped and spatial-temporal correlations of these values with the flare onset have been studied. It can be demonstrated that the energetic flares are prepared by a substantial speed of magnetic field gradient increase.

Tracking the CME-driven Shock Wave on 05 March 2012

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We present a multiwavelength study of the 05 March 2012 solar eruptive event. The X1.1 flare from the NOAA AR 1429 near the north-east limb was accompanied by a full halo CME which propagated at a projected plane of the sky speed of about 1300 km/s. The eruption was associated with very strong radio flux in the metric range (650 000 sfu) and a long lasting type II radio burst. Almost nine hours of rather continuous radio emission of interplanetary type II burst, observed by STEREO/Waves A and B and WIND/Waves instruments, enable efficient tracking of the propagation of the shock wave observed from different perspectives. We track the shock wave up to 1 AU.
The CME propagation is reconstructed in three dimensions using SOHO/LASCO coronagraph observations and STEREO COR and HI instruments, and additionally modeled with the ENLIL/cone model. We compare the kinematics of the shock wave and the kinematics of the CME, both observed in three dimensions, with the aim of locating the part of the CME-driven shock which generates the radio emission.

Dynamics of solar active longitudinal Zones

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The migration of solar active longitudes has been followed between 1977-2011 by using the DPD (Debrecen Photoheliographic Data) sunspot catalogue. The localization of the active zone allows to determine its width, activity variation and the flip-flop phenomenon. The extension of the active zone is varying, at lower activity level it is about 20-30 degrees wide. Around the maximum of the cycle it broadens and exhibits an activity variation with a period of about 1.3 years, similar to the period of radial torsional oscillation at the tachocline.

CASSIS - Considerations for Collaborative Environments

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There is an increased desire to study cross-disciplinary science problems and space weather falls into this category. While special provisions must be made to gather data in a timely fashion to facilitate near-realtime space weather forecasting, to understand the causes of the effects requires the ability to study the relevant phenomena in more detail. If the resources that various projects have established could be harnessed in a more general Collaborative Environment then it would be must easier to undertake the necessary research.

The Coordination Action for the integration of Solar system Infrastructures and Science (CASSIS) is examining ways in which this could be achieved through improving the interoperability between capabilities through the adoption of standards related to metadata and service interfaces. The project involves nine partners from Europe and the US together with a number of associate groups.

CASSIS has been examining existing metadata and interfaces associated with the HELIO, SOTERIA and Europlanet RI projects to find ways where the metadata are inhibiting the ability to do joined-up science. It is now staring to extend this study and to discuss possible options with other projects with the ultimate aim of allowing existing capabilities to work more closely together.

We will report on the work that has been done so far and welcome discussion with and input from all interested projects.

Maritime Radio Systems Performances in the High North (MARENOR)

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As the activity level is increasing in the Arctic, there is also a growing focus on safety and efficiency of maritime and marine operations. Support systems based on Global Navigation Satellite Systems (GNSS) and digital communication are being developed and taken into use. However, the environmental and space conditions in and over the Arctic opposes navigation and communication systems to challenges different from other places on Earth. Ionospheric and atmospheric effects, harsh weather conditions leading to rapid vessel movements, icing on antennas and other outdoor equipment, low elevation angles, poor groundbased communication infrastructure and system architectures are elements that have an effect on the total performance of the navigation and communication systems. MARENOR will develop a tool for total quality of assessment on such systems. This will be achieved through measurement campaigns and analysis.

The main objective of MARENOR is to quantify the system performance of the most common navigation and communication systems being used by maritime users in the High North. This will be achieved through measurement campaings and analyses of:

1. System architecture, 2. Signal propagation (L-, C-, Ku-, Ka-band),
3. Signal degradation factors (ionosphere, atmosphere, ship movements, position, icing on antennas).

The expected result is a model and tool for quality of system assessment on navigation and communication performance at high latitudes.

In this paper, we present an overview of the MARENOR project, summarise the processes that exhibit degrading effects on radio signals traversing the Earth's ionosphere and an outlook on possible correction mechanisms.

TI Capabilities of Brazilian Space Weather Program

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INPE

The Brazilian space weather program was created in 2008 with support from the Ministry of Science and Technology and aims to establish a Space Weather Information and Prediction Center in Brazil. For already have competencies in space science, INPE (Brazilian National Institute for Space Research) led the implementation of the program and has carried out actions in this direction for two of its divisions, the division of Space and Atmospheric Sciences and LAC - Laboratory for Computing and Applied Mathematics.

The first actions of the program were to incorporate the existing sensor networks and install new sensors necessaries for the Prediction Center Operation. As an example of embodiment, we can cite the merger of a network of a 18 GPSs stations under responsibility of Aeronomy Research Group. These GPS stations today are sources for generating maps of Ionosphere Scintillation on Brazilian territory. New sensors, such as a network of magnetometers, are being installed along the relevant geomagnetic lines.

In general, Brazilian Space Weather Systems must provide some typical computing activities like data collection, data processing, modeling (prediction) and dissemination of results. This includes consider some sources and data coming from: solar radio telescopes, ionosphere sounders/Ionossondes, GNSS receivers, Magnetometer arrays, optical imagers, radio frequency radars, sensors induced current, ionosphere modeling.

These stations generate data at different volumes and frequencies, which range from a few seconds to a few hours. Furthermore, it's necessary to receive such data in (near) real time to perform monitoring 24 hours per day, 7 days per week.

To meet this demand, the architecture for this system was created, allowing us to receive large volumes of data with low latency, processing-intensive applications and reducing the possibility of data loss. Establishing a central monitoring and a high level of application availability are also keys issues and are taken into consideration to define the system architecture.

The IT architecture of the Brazilian space weather program is based on a system called Pipeline, which allows the continuous flow of information from the instruments into the servers of the program. In this scheme an application suite implements the data pipeline, which is established for each instrument.

The application that is closest to the sensor is called collectorAgent and is responsible for receiving the device data, perform the initial processing to convert into a standard transmission format and send the data to the next Pipeline stage. CollectorAgent is also responsible for handling problems with data delivery. Each device connected to a sensor has an instance of the collectorAgent.

The next stage of the pipeline is implemented by an application called ReceptorGateway. This application is responsible for receiving data from collectorAgents. An instance of this application is running in our operations center. The "ReceptorGateway" forwards the data to the processing queues. Each queue stores the data of a different category of equipment. The inclusion of data from a specific queue triggers the execution of applications for processing each data type.

The third stage of the pipeline scheme are application that consume data from the queue and perform the processing data. These applications are called Loaders. In general, they perform the data reading, post processing and storage of records in the database. This process ensures standardization in data storage and allows better management of information.
The database stores the data collected by sensors, meta-data from instruments and acquisitions.

After storage of data in the database, another set of other applications are responsible for generating products to display data. The visualization system is web based. Currently viewing products that are already available are: Geomagnetic Components of the network of Magnetometers, K index of Magnetometers, Solar Radio Frequency Spectrometer, Ionospheric Scintillation, Scintillation Videos, Ionosonde Data and graphics from the Ionosonde foF2.

Progress in Understanding the complex solar Event of September 13, 2005

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Some solar flares can release acoustic transients into the solar subsurface of the active regions that host them. Most of the acoustic power in these transients propagates something like 10-30 Mm beneath the photosphere before it is refracted back to the surface, where it creates a significant disturbance. In the strongest of these "sunquakes", the manifestation of this transient in helioseismic movies is an outwardly expanding surface ripple that becomes conspicuous about 20 minutes after the impulsive phase of the flare. Sunquakes offer a powerful diagnostic of wave propagation in the active region photosphere and of the structure and dynamics of the subphotosphere.
On September 13, 2005 an X1.5 flare erupted above the beta\gamma\delta AR NOAA 10808. The integrated GOES flux started to increase at 19:19 UT, reached the peak at 19:27 and ended one and a half hour later. Simultaneous with this fast rising ascending phase, we discovered a sun quake that had its maximum at 19:22 UT. We will present and discuss the associated Moreton wave as well as possible connection in between these emissions. We are also investigating a possible connection between this event and the halo CME that started at 20:00:05 UT.

Solar wind stream Activity during the Modern Great Maximum: Direct Support for Solar Dynamo Theory

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We present and use a novel method to find the years with the largest amounts of fast solar wind streams at the Earth's orbit during the last 85 years, i.e., during most of the Modern Great Maximum (MGM) of solar activity. Two independent series of observations agree that the strongest solar wind speeds occurred in the declining phase of solar cycle 18. Since high solar wind speeds indicate strong solar polar magnetic fields, we find that cycle 19, which formed the peak of solar activity during MGM, was preceded by a time with the strongest poloidal field of MGM. According to the solar dynamo theory, strong solar polar magnetic fields (poloidal magnetic field) during a solar minimum should lead to an intense sunspot activity (toroidal magnetic field) during the next solar maximum. While this basic tenet has earlier been proven statistically, it has remained untested for the highest activity period of measured history until now.

Data and model Resources of the Ionospheric Weather Site

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The ionospheric weather products are provided at http://www.izmiran.ru/services/iweather/. Relevant global maps in latitude [-90:2.5:90] and longitude [-180:5:180] of the F2 layer critical frequency (foF2), the peak height (hmF2), and a proxy of ionospheric activity (W-index) are reconstructed from GIM-TEC map with the International Reference Ionosphere model extended to the Plasmasphere, IRI-Plas. The foF2, hmF2, W-index and their deliverables are provided both in IONEX map format and in hourly-monthly files for selected locations of 60 observatories worldwide and their magnetic conjugate locations in the opposite hemisphere. Missed ionosonde observations are replaced by TEC-based predictions from the relevant map products of foF2 and hmF2. Daily update and forecast of above parameters is provided online with open access to the users community.

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Operational Mapping of the ionospheric W index Maps

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A paper present a physical and structural scheme of an operational system for plasmasphere-ionosphere plasma description and forecast; a system to give information about possible disturbances phenomena that have an impact on current quality of the GPS signal. This information is necessary for warning about possible degradation of the signal and even loss signal lock what in consequence drastically decreased precise of positioning. Information about it is needed in near-real time. This type of maps are of interest to users in that they can provide information on prevailing tracking conditions, especially during disturbances. Moreover they could be useful for GNSS positioning accuracy improvement by applying weights to individual satellite to receiver.

Disturbances under specified circumstances, may be overcome by introducing a W index that describes the perturbation degree of the ionosphere. Such an index does not describe the exact propagation conditions at the measurement site, the derived quantity, a scaled index number, indicates the probability of a possible impact on radio systems used in communication, navigation and remote sensing.

Calculated forecast of indices and/or maps such as W show capabilities of the applied method description of the propagation conditions with sufficient accuracies during even stormy conditions.

Nowcast Server for geomagnetically induced Currents

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During the latest years, availability of real-time ground magnetometer data has become a well-established routine. This has made it possible to provide up-to-date modelling of geomagnetically induced currents (GIC). Within the FP7/EURISGIC (European Risk from Geomagnetically Induced Currents) project, such a nowcast test server is running for the Finnish and North-West Russian high-voltage power grids and the Finnish natural gas pipeline

(http://space.fmi.fi/image/realtime/eurisgic/).

The input consists of real-time data from 13 IMAGE magnetometer stations in North Europe, 1-D block models of the ground conductivity, and a DC description of the power grids and the pipeline. This test has run since spring 2012 without any major problems. The next step, presently under development, is an extension to forecasting based on magnetohydrodynamic simulations starting from in-situ solar wind measurements. The nowcast server, as well as the forthcoming forecast server, is generic in that it is applicable in any geographic scale. Because the method determines ionospheric (equivalent) current densities, it also serves as a real-time monitor of ionospheric electrojets giving more quantitative information than the traditional AU/AL-type indices.

Study of geoeffective CMEs kinematics during the solar cycle 23

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In this study we have analysed the coronal mass ejections (CMEs) during the solar cycle 23, which have produced major geomagnetic storms (Dst < -150 nT). The analysis is focused on the calculation of the real speeds of CMEs directed towards the observer (using the sphere model of a CME) and comparison with the speeds of corresponding interplanetary CMEs, measured at ACE. Correlations between CMEs parameters and geomagnetic indexes have been done in order to improve the space weather prediction, based on near-Sun signatures.

Relative Importance of dusk-ward electric Fields and time Interval in the Decrease of Dst

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Empirical studies have related the minimum value of the geomagnetic storm Dst index to interplanetary parameters. Recently Ji et al. [2010] suggested that three conditions are candidates to trigger an intense storm: Bs > 10 nT for more than 3 hours, VBs > 5 mV/m for more than 2 hours, and Bs > 15 nT or VBs > 5 mV/m for more than 2 hours.
During the first stages of a geomagnetic storm, with small values of the Dst index, the losses term in the Burton's equation is still insignificant relative to the injection function term. As a consequence, in the initial stages of the storm, from Burton's equation, the Dst decrease is proportional to the product of VBs and Ät. Then, if Ät is fixed at 3 hours, an intense storm will be developed by a duskward electric field of about 6 mV/m, which is close to the suggested empirical criteria mentioned above. This presentation deals with the relative importance of the terms VBs and Ät involved in reaching a ÄDst value. Our results provide the timescale to assume, or not, that an empirical source function for Dst proportional to VBs represents energy injection into the ring current plasma.

A Collaborative FP7 Effort towards the First European Comprehensive SOLar Irradiance Data Exploitation (SOLID)

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SOLID is an FP7 collaboration of 10 European partner institutions addressing solar irradiance research with the aim to provide the first European solar irradiance data set. The project is intended to start in 2013 and will be funded by the European Commission. The focus of the project is the comprehensive analysis of solar irradiance variations which are the most important natural factor driving the terrestrial climate and as such a crucial input to any climate modelling. There have been previous efforts to compile solar irradiance but there are still large uncertainties on spectral and total solar irradiance variations on time scales exceeding a few solar rotations and in particular the long term trend. Numerous disperse observational records or irradiance exist. Therefore, it is important to bring together the European expertise in the field to analyse and merge the complete set of European irradiance data, complemented by archive data as well as data from non-European missions. We report on the initiation of a collaborative effort to unify representatives from all European solar space experiments, European teams specialized in multi-wavelength solar image processing along with the European groups involved in irradiance modelling and reconstruction. They will work with two different state of the art approaches to reconstruct spectral and total solar irradiance data as a function of time. These results will be used to bridge gaps in time and wavelength coverage of the observational data. One goal of the proposing SOLID team is to reduce the uncertainties in the irradiance time series - an important requirement by the climate community - and to provide uniform data sets of modelled and observed solar irradiance data from the beginning of the space era to the present including proper error and uncertainty estimates. Climate researchers need these data sets and therefore, the primary benefit of this project is for the climate community, but the stellar community, planetary, lunar, and ionospheric researchers are also interested in having at their disposition incident radiation of the Sun. The proposing team plans to realize a wide international synergy in solar irradiance research from 7 European countries including collaborators from the US and complemented by representatives from the climate community, who will accompany this project with wide dissemination activities.

The Ozone Production at 40°, 60° and 80° N caused by cosmic Ray Flux during the SPE on 20.01.2005

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The appearance of Solar Particle Event (SPE) is accompanied by different processes and phenomena in the terrestrial atmosphere. One such basic phenomenon is the complementary ionization which it causes. In dependence on the SPE power, the phenomenon Ground Level Enhancement is observed when there is Solar Cosmic Ray (SCR) flux ejection with energy above 100 MeV. In that case a high energy particle flux penetrates and causes cascade processes in the atmosphere. Their products reach the Earth surface and are registered in the neutron monitors. Such phenomena occur during the events from 17 and 20 January 2005 (GLE 68 and 69). The ionization rate profile appreciation in result from the processes mentioned above is usually a hard and painful problem because of the complexity of the corpuscular-electromagnetic cascades in the atmosphere. Generally the ionization rate is calculated at the starting point of the event or some points near it [1, 2, 3]. That appreciation is necessary to characterize the momentary ionization state and the processes and the effects which are related to it. But it is not enough. The calculation of the ion production at different moments is very interesting with the purpose to follow in time the development of the ionization process and the effects from it. The most elementary case is the evaluation of ionization profiles at the starting and the end point of the investigated time period. The ion production which is determined concretely for the SPE from 20 January 2005 is given in [4]. In the present work on the base of calculated profiles of ionization of the proton flux generated by a solar proton event of 20 January 2005 (GLE 69) are calculated profiles for the production of ozone for 15 hours. A comparison between the ozone production at 40, 60 and 800 degree of Northern latitude is made. The obtained ozone production profiles show maxima at different altitudes. The highest maximum is situated at polar latitudes, the lowest maximum - at middle latitudes. The ozone production is highest at polar latitudes - the production at 600 N is 1,4% from the production at 800 N. At 400 N it is 0.085% from the production at polar latitudes.

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Relationship at long-term Timescale between the Solar and Atlantic Ocean Variabilities and European Climate

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This study investigates the relationship between the surface air temperature at European continental scale and the variabilities of the solar activity and of the Atlantic Ocean. The solar and Atlantic Ocean variabilities are described, in our correlation analysis, by means of the sunspot number (R), and, respectively, the North Atlantic Oscillation (NAO), one of the important modes of large-scale variability in the Northern Hemisphere, and of the Atlantic Multidecadal Oscillation (AMO). A robust and reliable data set of long records of air temperature for Europe (35 stations, 1900-2006) was used. The time series were filtered by means of 11- and 22-year running averages and the corresponding variations were compared to solar and Atlantic Ocean variabilities. Strong and coherent solar signals have been found at Schwabe and Hale solar cycles timescales at all analyzed stations with amplitude differences that can be understood in terms of large-scale atmospheric circulation patterns.

What do past solar Irradiance Observations tell us about recent solar Variability in the UV ?

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The solar spectral variability during the latest solar cycle and in particular the behaviour of the solar UV is a timely and hotly debated topic. Recent observations from SORCE suggest that the variability in the UV may significantly differ from what was observed during earlier cycles. If confirmed, these results raise the possibility for the variation of stratospheric ozone to significantly depart from current expectations.

Several satellites have been monitoring the solar spectral variability in the UV since the late 70's. However, very few observations span more than one solar cycle. In addition to that, they often disagree and are affected by sensor degradation. There remains a considerable issue in merging these disparate observations into a single composite UV data set, with the aim to assess the long-term variability.

We built such a composite by using a Bayesian framework, which allows to properly handle uncertainties. The outcome is one single composite spectral irradiance dataset for the UV (120-410 nm), which clearly reveals the departure of recent measurements by SORCE from past observations.

Correlation between Sunspot Numbers and EUV Irradiance as observed by LYRA on PROBA2

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The solar radiometer LYRA on board the ESA micro-satellite PROBA2 has observed the Sun continuously since January 2010 in various spectral bandpasses. Two of the LYRA channels cover the irradiance between soft X-ray and extreme ultraviolet. The variation of the sunspot number appears to show a strong similarity with the variation of these channels, when their long-range development is taken into account, i.e., their daily irradiance minima without flaring activity. We will try to give some explanations, and complement the findings with other instruments' (GOES, PROBA2/SWAP) results.

Solar Influences on atmospheric Circulation

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Various atmospheric parameters are in some periods positively and in others negatively correlated with solar activity. Solar activity is a result of the action of solar dynamo transforming solar poloidal field into toroidal field and back. The poloidal and toroidal fields are the two faces of solar magnetism, so they are not independent, but we demonstrate that their long-term variations are not identical, and the periods in which solar activity agents affecting the Earth are predominantly related to solar toroidal or poloidal fields are the periods in which the North Atlantic Oscillation is negatively or positively correlated with solar activity, respectively. We find further that solar poloidal field-related activity increases the NAM index, while solar toroidal field-related activity decreases it. This is a possible explanation of the changing correlation between the North Atlantic Oscillation and solar activity.

Is Cloud Cover Modulation related to the Interplanetary Magnetic Field?

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Cloud cover represents an essential component in the terrestrial radiation budget. The influence of solar activity and of the interplanetary magnetic field (IMF) on terrestrial cloud cover and on other atmospheric parameters has been studied by scientists around the world since some time ago. There are strong disagreements between the conclusions drawn concerning these subjects and they refer to the time scales, data sources, or other factors. However, the variability of the solar irradiance itself is too small to explain its influence on climate parameters (Gray et al., 2010). Indirect effect of solar variability on climate are searched, based on mechanisms involving other solar proxies, such as cosmic rays (CR) and solar ultraviolet irradiance (UVI), which, probably, act together on clouds. Climate changes have been already correlated with the intensity of cosmic ray flux, since CRs affect the cloud condensation nuclei abundance and hence the global cloud properties and climate. Also, the neutron monitor data show that galactic cosmic ray (GCR) fluxes vary with the strength of IMF, which is modulated by the Sun.

Considering all these issues, this paper proposes the analysis of the link between CR, IMF and cloud cover and the possible dependence on altitude and composition. The studied period covers the years between 1984 and 2009. Since correlations have been found between temperature and geomagnetic activity and the latter depends on IMF, it is important to establish whether this the main trigger links to the geomagnetic activity (and thus to CR flux variation) or to solar wind variations.

Long Term Impact of Solar Cycle on Meteorological Parameters at Huancayo

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Universidad Complutense de Madrid

Huancayo Observatory (12°S, 75° W) is one of the most complete Observatories at Equatorial Region in Peru, South America , with one of the longest Meteorological data recorded since 1920.

Parameters related to the Earth's lower atmosphere are usually studied for short term or medium term time scales . Cosmic Ray and Solar irradiance are considered for correlation studies with solar cycle. In this report we present particular observations of 2D time/time maps which can ilustrate seasonal and long term changes. We observe the influence of the 11 year solar cycle in the Pressure monthly mean, and the Temperature (max/min) monthly mean. It is important the consideration of such influence in long term atmospheric models.

The role of this long-term solar activity variation and its impact in the evolution of Pressure and Temperature is clearly seen in these local data. Rain observations show more noisy variation in seasonal changes but we can see correlation with phase of solar cycle. We also discuss and compare observed variations with magnetic and ionospheric parameters.

Space Weather Extremes -Earth Climate Abnormalities-Agriculture Crashes-Famines: is this causal Chain real?

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We analyze possible causal chain from solar activity/space weather to earth weather and agriculture production. We show that this scenario in principal cannot considered as universal, but may has place in selected regions and during specific historical periods, when several necessary conditions has place simultaneously (sensitivity of local weather to space weather, sensitivity of local agriculture production to local weather condition (belonging to "high risk agriculture zone"), isolation of local agriculture market, preventing to external to supply external cheap corn). Since the most drastically form of corn deficit is mass famine, we analyze statistics of famines in Iceland and India and show high reliable correlation of famine events with extreme states of space weather/solar activity.

A Strategy for Estimation of specific Climate Sensitivities from SSI Reconstructions and paleoclimatic Records

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I describe a strategy for obtaining an empirical assessment of the specific climate sensitivity to solar forcing relative to volcanic, orbital and anthropogenic forcing. The main goal is to assess the relative importance of the ultraviolet (UV) part of the solar spectrum compared to the total solar irradiance (TSI). Another is to assess the significance of coherent cycles in the global temperature signal relative to a climate noise component characterized by long-range memory (LRM). This LRM is a mathematical representation of the multiplicity of different response times of the climate system.

The research strategy is based on utilizing available data on radiative forcing and their reconstructions, augmented by a statistical model of solar and volcanic forcing beyond the holocene, and data on global and hemispheric climate variability on a vast range of time scales. The main uncertainties in these data are the relative weights between solar, volcanic and orbital forcing, and for solar forcing; the relative weight between the forcing from UV variability and TSI variability. We denote these weights the specific climate sensitivity parameters.

The next step is to decompose the forcing signals into deterministic and stochastic components. This analysis yields a number of model parameters, such as memory exponents, intermittency parameters, and frequencies and power in cyclic components of the forcing, but the climate sensitivity parameters are still unknowns. The main product here is a stochastic model of the total forcing signal parametrized by the specific climate sensitivity coefficients.

Finally the modeled forcing signals and the climate response records are fed into a dynamic-stochastic model for the global temperature with long-range memory response, and a maximum-likelihood statistical method is employed to determine the specific climate sensitivity parameters. Estimates of these climate sensitivity parameters, and their confidence limits, are the main deliverables of this project.

Effect of Teleconnections on the possible Link between Cloud Cover and Solar Variability

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Clouds play a very important role in the climate system. They could be seen as a complex filter of the solar radiation reching the Earth surface. Their albedo represents the most important factor of negative radiative forcing on Earth. It is generally considered that high clouds tend to heat, while low clouds tend to cool the low troposphere, so that cloud variation has a high impact on climatic variability. The effect of solar activity on climate, in our case on clouds, is most likely mediated by internal climatic factors, especially by teleconnections. Therefore we aim at understanding some characteristics of the global distribution of the relationship between internal climatic oscillations, as for instance teleconnections, and different types of clouds. Teleconnections are links between atmospheric anomalies over great distances, which often manifest as persistent relationships between pressure fields of various geopotential heights at far-apart locations (Glantz 1990). Our goal is to separate between geographical regions where atmospheric teleconnections play an important role in the formation and evolution of clouds and at finding whether these relationships compete, cancel or amplify possible solar effects on clouds. Indices of several teleconnections will be used together with cloud cover data collected by satellites. The climate may respond differently during periods of high and low solar activity to both internal and external climatic triggers, thus separation between years of high and low solar activity is also considered when analyzing the cloud-teleconnection relationship.

Circulation Changes in the winter lower Atmosphere and long-lasting solar/geomagnetic Activity

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The paper describes the association between high long-lasting solar/geomagnetic activity and geopotential height (GPH) changes in the winter lower atmosphere, based on their development in the Northern Hemisphere in the winter periods (December-March) of 1951- 2002. Solar/geomagnetic activity is characterized by the 60-day mean of the R number/by the 60-day mean of the daily sum of the Kp index. The GPH distributions in the lower atmosphere are described by 60-day mean anomalies from their long-term daily average at 50 hPa/500 hPa. The data have been adopted from the NCEP/NCAR re-analysis. The 60-day mean values of solar/geomagnetic activity and GPH anomalies were calculated in five-day steps over the whole winter period. The analysis was carried out using composite maps which represent the distribution of GPH anomalies during high ($R \geq 110$) solar activity and high ($\sum Kp \geq 21$) geomagnetic activity. The composite maps, created on the basis of solar activity data, show significant anomalies of GPH in the lower stratosphere and in the troposphere. They display a positive significant anomaly in the band of low and middle latitudes in the lower stratosphere and statistically significant anomalies, small in area, in the middle troposphere. A statistically significant instance of a positive anomaly in the lower stratosphere was noted during the whole examined period. The composite maps, created on the basis of geomagnetic activity data, show significant anomalies of GPH in the lower stratosphere. Positive anomalies are to be observed in the low and middle latitudes, and negative anomalies in the polar region. The composite maps relating to the middle troposphere display an ordering of significant anomalies, which is indicative of a positive phase of the North Atlantic Oscillation (NAO). A significant positive anomaly in the lower stratosphere was observed in all analyzed intervals, and a significant negative anomaly in the lower stratosphere was observed in two analyzed intervals. The positive phase of the NAO was noted during the whole examined period. The change of relationship between solar/geomagnetic activity and the distribution of GPH anomalies in the lower atmosphere, taking place at the beginning of seventies, is documented by means of scatter diagrams. The statistical significance was computed using the Monte Carlo method.

Revision of the absolute Level of the DIARAD type Radiometer.

Dewitte, Steven; Janssen, Els; Chevalier, André; Conscience, Christian; Bali, Sami
RMIB

The RMIB has a long tradition with the Differential Absolute Radiometer (DIARAD) for the measurement of Total Solar Irradiance (TSI) from space, with in total eleven space flights, and currently two active instruments in space. Our latest instrument is the Sova-Picard one which was launched in June 2010, and our longest measuring one is DIARAD/VIRGO on SOHO, which has been measuring over more than one solar cycle since 1996. While a stability of the order of 0.1 W/m^2 has been achieved, an uncertainty on the absolute level of several W/m^2 remains. In this presentation we will show the results of a critical re-investigation of the determination of the absolute level of our instruments. We take into account the hitherto neglected effect of thermal heat losses for the electrical heating of the DIARAD cavities.

This leads to a reduction of the absolute level of the DIARAD type radiometer.

Climate variability - a Concert for O3, H2O Vapour and "Orchestra"

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The abrupt increase of the Earth's near surface air temperature during the last several decades, tips the scales in favour of the view that solar variability has a minimal impact on climate change. This conclusion is based on the analysis of that part of solar radiation (visible and near infrared bands of solar spectrum), which have a direct influence on the surface air temperature. After a thorough analysis (linear and non-linear) of the factors effecting Earth's climate, we found out an alternative factor describing even greater part of the land air temperature variability than increased CO2 concentration, and this factor is the lower stratospheric ozone.
In this presentation we will describe the mechanism of ozone influence on climate. Revising some widely accepted, but mined by severe shortcomings, concepts - related to the ozone and climate formation factors - we offer an attempt "to see the forest not simply the individual trees", reducing uncertainties in our knowledge and offering answers to some unresolved problem. The non-linear analysis of ozone data reveals that all four examined factors, i.e. stratospheric chlorine, atmospheric circulation index (Vagengeim-Girs index), multi-decadal variability of sun spot numbers and galactic cosmic rays (GCR), have a substantial impact in the long-term ozone variability. GCR, however, describe the greatest part of ozone variations. The real foundation of this statistical relation has been confirmed by our ion-chemical model of the lower stratosphere. The ozone produced from the ion-molecular reactions (initiated by GCR) is comparable with the peak ozone density and consequently capable of distortion the lower stratospheric ozone profile. This result has been related to the previously reported connection between ozone and temperature in upper troposphere/lower stratosphere. The temperature variations, however, are inevitably connected with humidity variations near tropopause, and consequently with energy balance of the planet. The temporal variations and spatial distribution of this O3-H2O forcing over the globe will be discussed.

Building a new Composite of the total solar Irradiance out of several Observations

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For several years now, many attempts have been made to merge all total solar irradiance (TSI) observations into a single composite with the aim to assess the presence of long-term trends in the solar radiative output. Three composites have been derived that way, based on different assumptions, and also yielding different trends.

Because this issue is so important for climate studies, other approaches are now being considered for making/testing such composites. Here we consider a novel approach in which a Bayesian framework is used to extract a consistent TSI composite that is compatible with all the observations, given their uncertainties.

We show how a distribution of the TSI is obtained, whose most probable value yields a new composite that differs from the existing ones but still is in good agreement with the results from spectral irradiance models.

Lower Ionosphere and Solar Events Forcing

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There are two basic channels of solar activity impact on the lower ionosphere (ionosphere below 90-100 km), which is embedded in the mesosphere and lowermost thermosphere. The first one is through changes of solar electromagnetic ionizing radiation, solar EUV and X-ray flux; particularly the X-ray flux can change by orders of magnitude both during the 11-year solar cycle and strong solar flares. The other channel is via variable solar wind and its interplanetary magnetic field (IMF), which cause geomagnetic storms and other space weather/climate phenomena including variability of penetrating/precipitating high-energy particle flux and via modulation of galactic cosmic rays by IMF. The lower ionosphere response to solar forcing has been studied for more than 50 years by various ground-based methods and with the use of in-situ rocket measurements. The sources of solar activity impact on the lower ionosphere and methods used for investigating lower ionosphere response will be summarized and selected results will be presented. It should be stressed that during strong events of solar origin the electron density in the lower ionosphere may be enhanced by more than an order of magnitude. Variable occurrence frequency of strong events of solar origin has also impact on climate of the lower ionosphere.

Phase Coherence between solar/geomagnetic Activity and climate Variability from Stratosphere to Troposphere

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Geographical distribution of statistically significant phase coherence among oscillatory modes with the period of approximately 7-8 years detected in monthly time series of geomagnetic activity aa index, NAO index and ERA-40 and NCEP/NCAR air temperature was studied. Both the reanalysis datasets provide consistent patterns of areas with marked, statistically significant coupling between solar/geomagnetic activity and climate variability observed in continuous monthly data, independent of the season, however, confined to the temporal scale related to oscillatory periods about 7-8 years. The role of NAO in the transfer of solar/geomagnetic influence from stratosphere to troposphere is discussed.

Solar Activity - Climate: A critical Review

Stauning, Peter
Danish Meteorological Institute

The presentation of solar activity-climate relations is extended with the most recent sunspot and global temperature data series. The extension of data series shows clearly that the changes in terrestrial temperatures are related to sources different from solar activity after ~1985. Based on analyses of data series for the years 1850-1985 it is demonstrated that, apart from an interval of positive deviation followed by a similar negative excursion in Earth’s temperatures between ~1923 and 1965, there is a strong correlation between solar activity and terrestrial temperatures delayed by 3 years, which complies with basic causality principles. The shortcomings of the solar-cycle length-climate model and of the cosmic radiation-cloud-climate model are discussed. It is suggested that the in-cycle variations and also the longer term variations in global temperatures over the examined 135 years are mainly caused by corresponding changes in the total solar irradiance level representing the energy output from the core, but further modulated by varying energy transmission properties in the active outer regions of the Sun. Regression analysis between solar activity represented by the cycle-average sunspot number, SSNA, and global temperature anomalies, ÄTA , averaged over the same interval lengths, but delayed by 3 years, has shown that the total solar activity-related changes in global temperatures could amounts to no more than ±0.4°C over the past ~400 years where the sunspots have been recorded

A Study on the Analysis of the Performance Degradation of Wireless Communications System by Solar Radio Burst

Lee, Yong-Min[1]; Jeong, Cheol-Oh[2]; You, Moon-Hee[2]; Jo, Jin-Ho[2]
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Solar Radio Bursts (SRBs) generated by solar activities can effect on wireless communications systems as an initially unexpected and unrecognized jamming signal. The analysis on the performance degradation by SRBs for several key wireless communications system such as LTE, Wi-Fi, and GPS have been carried out and concluded with near term activities.

Space Weather in the Cloud: A Platform as a Service (PaaS) for SWE Models

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[1]Rhea System S.A.; [2]Logica; [3]The Server Labs

Space Weather Software Models are used to support analysis and forecasting of space weather phenomena and the effects of these phenomena on spacecraft and other critical infrastructure.

Exploitation depends on efficient ICT infrastructure for coupling models and supporting heterogeneous execution; software, hardware and networks capable of supporting challenging CPU and communication requirements. Recent developments in technology known as "the cloud" offer significant benefits such as flexibility and immediate scalability ("elasticity") are particularly suited to these challenges

We will present the concepts and interim results of a study being conducted for ESA on this topic. The overall objective of the study is to assess needs and define a blueprint for an ESA-wide cloud solution, comprising two layers:

 A common IaaS (Infrastructure as a Service) in which the service provided to users consists of access to virtual servers, likely to be deployed as a combination of private and public cloud services. The technical solution is complemented by strong focus on security and governance aspects.
 Complementary Paas (Platform as a Service) layers, in which the service provided to users is to submit and execute domain-specific applications or jobs, in a standard format defined by each specific platform. PaaS provides users wth the building blocks and semantics for handling scalability, fault tolerance, etc. in their applications.

The study will define a Space Weather PaaS. The Space Weather PaaS would offer a set of standard tools/services/API that allow execution and management of models, using the services offered by the underlying IaaS layer.

100-th Anniversary of CR Discovery, different Aspects, Applications to Space Weather Problems

Dorman, Lev
Tel Aviv University and IZMIRAN

We describe the history of cosmic ray (CR) discovery from the end of 19th century, and why this phenomenon obtained wrong name, discovery of the first anti-particle (positron), mesons and hyperons in CR, development of different aspects of CR research. We consider also very important applications of CR to the problem of space weather effects on satellite operation (satellite anomalies), aircrafts, electronics, people health, agriculture production, and climate change.

Dangerous Magnetic Storms and their Forecasting by using CR Data from Neutron and MUON Detectors

Dorman, Lev
Tel Aviv University and IZMIRAN

1. Why magnetic storms are dangerous (people health, induced electric currents, communications, car accidents, train accidents, satellite malfunctions/anomalies)
2. How to correct data of neutron monitors and muon telescopes on local meteorological effects in real time scale (for neutron component - mostly barometric effect; for muon component -mostly barometric effect + temperature effect; data on air pressure; satellite data over the globe of temperature vertical distribution each 6 hours; using ground one hour data and kaminer's method - obtain one hour data for temperature vertical distribution)
3. What precursory effects can be used for forecasting (we discuss here three phenomena that can be used for forecasting FDs: 1) CR intensity increase, of non solar CR origin, occurring before sudden commencement of a major geomagnetic storm connected with FD (preincrease effect), 2) CR intensity decrease before FD (predecrease effect), 3) change in CR fluctuations before FD. We analyse the behaviour of the isotropic CR intensity and of the 3-dimensional vector of CR anisotropy before FDs, as well as results on CR scintillation of 1-hour and 5-minute data).
4. The final aim: how to organize the work of world-wide network of neutron monitors and muon telescopes (very important both) for continue forecasting of dangerous magnetic storms

PC Indices: Relations to further geophysical activity Parameters

Stauning, Peter
Danish Meteorological Institute

The Polar Cap (PC) indices, PCN for the index values derived from Thule magnetic data and PCS derived from Vostok data, relate to the polar cap ionospheric plasma convection driven mainly by the interaction of the solar wind with the magnetosphere. Thus, the PC indices serve to monitor the input power from the solar wind that drives a range of geophysical disturbances such as magnetic storms and substorms, energization of the plasma trapped in the Earth's near space, auroral activity, and heating of the upper atmosphere. The presentation will demonstrate the close relations between the PC indices, considered to represent the solar wind source, and further geospace parameters and indices used to describe geophysical activity such as polar cap potentials, auroral electrojet activity, Joule and particle heating of the upper atmosphere, mid-latitude magnetic variations, and ring current indices Dst, SYM-H and ASY-H.

An EOF based regional climatological Model of TEC over Australia.

Zahra, Bouya[1]; Terkildsen, Michael[2]; Francis, Matthew[2]
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This paper proposes a new approach to develop a climatological regional model for the Total Electron Content(TEC) over Australia using Spherical Cap Harmonic Analysis (SCHA) and Empirical Orthogonal Function (EOF) techniques.
The SCHA method was firstly used to estimate TEC at evenly distributed grid points from GPS data collected from the Australian Regional GPS Network (ARGN). The SCHA model is based on longitudinal expansion in Fourier series and fractional Legendre co-latitudinal functions over a spherical cap-like region including the Australian continent. This harmonic expansion requires less coefficients to represent the fine structure of regional ionospheric features than global Spherical Harmonic Analysis (SHA). EOF analysis was then used to decompose the TEC dataset into a series of orthogonal Eigenfunctions (EOF base functions) and associated coefficients. The base function represents the variation in TEC with latitude and longitude. The coefficients represent the variation with time. The importance of different type of variation to the overall TEC variability as well as the influence of the solar radiation and geomagnetic activity is well presented by the characteristics of the first four EOFs and associated coefficients.

Historical Sunspot data Analysis in the Context of the COMESEP Project

Lefevre, Laure[1]; Frederic, Clette[1]; Susanne, Vennerstrom[2]
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The aim of the COMESEP project is to develop forecasting tools for both SEP radiation storms and geomagnetic storms. The analysis of historical data, complemented by the extensive data coverage of the SOHO era (after 1996) will help identify the key factors that lead to extreme space weather events, thus enabling more precise forecasting. To this end, we have selected a subset of the most important geomagnetic storms during the last 150 years (starting in the mid 1800s) and have started gathering images, drawings and all the data available for each of these events.

Our first task, included in Work package 4, is to identify a set of sunspot parameters that can be used to describe further solar events/parameters (flares, CMEs, SEPs, geomagnetic storms). This set of sunspot parameters has to be readily available, i.e., even from old sunspot drawings, so that our database goes back as far as possible in the past. Once similarities are established it will give us information that can be used as input for the forecasting of space weather events. Here, we will present part of the data gathering process, the sunspot parameters we have been able to gather so far and the results of our analysis.

This work has received funding from the European Commission FP7 Project COMESEP (263252).

Kinetic Modeling of magnetic Reconnection in three Dimensions

Olshevsky, Vyacheslav[1]; Restante, Anna Lisa[1]; Lapenta, Giovanni[1]; Markidis, Stefano[2]
[1]KU Leuven; [2]KTH Royal Institute of Technology

We study the evolution of magnetized plasma from an initial configuration that contains several isolated null-points. The simulations are performed with implicit particle-in-cell numerical code in three dimensions. Magnetic reconnection sets up immediately after the beginning of simulations. We investigate how various parameters of the system influence the reconnection process and resulting magnetic field topology.

NASA GSFC CCMC recent model validation Activities

Rastaetter, L.[1]; Pulkkinen, A.[2]; Taktakishvili, A.[3]; Macneice, P.[1]; Shim, J.-S.[3]; Zheng, Yihua[1]; Kuznetsova, M. M.[1]; Hesse, M.[1]
[1]NASA/GSFC; [2]NASA/GSFC and CUA; [3]NASA/GSFC and UMD

The Community Coordinated Modeling Center (CCMC) holds the largest assembly of state-of-the-art physics-based space weather models developed by the international space physics community. In addition to providing the community easy access to these modern space research models to support science research, its another primary goal is to test and validate models for transition from research to operations.

In this presentation, we provide an overview of the space science models available at CCMC. Then we will focus on the community-wide model validation efforts led by CCMC in all domains of the Sun-Earth system and the internal validation efforts at CCMC to support space weather services/operations provided by its sibling organization - NASA GSFC Space Weather Center (http://swc.gsfc.nasa.gov). We will also discuss our efforts in operational model validation in collaboration with NOAA/SWPC.

3D implicit PIC Simulations of solar wind - body Interactions

Deca, Jan; Markidis, Stefano; Divin, Andrey; Lapenta, Giovanni
KU Leuven, CmPA

We present three-dimensional Particle-in-Cell simulations of an unmagnetized body immersed in the solar wind. The simulations are performed using the implicit electromagnetic Particle-in-Cell code iPIC3D [Markidis, 2009]. Multiscale kinetic physics is resolved for all plasma components (heavy ions, protons and electrons) in the code, recently updated with a set of open boundary conditions designed for solar wind - body interaction studies. Particles are injected at the inflow side of the computational domain and absorbed at all others. In particular, iPIC3D is applied to: 1) a spacecraft charging study and 2) a detailed investigation of wake physics behind a Moon-sized body.

Coupling Particle and wave transport Simulations

Afanasiev, Alexander; Vainio, Rami; Koskinen, Hannu
University of Helsinki

A number of simulation models were developed in the past to study the transport of solar energetic particles (SEP) as well as the propagation and evolution of plasma waves in the corona and interplanetary space. The particle transport models were based on the simplistic assumption that streaming particles being affected (scattered) by plasma waves do not have any effect on the waves. However, recent studies reveal that this is not the case and the back-reaction of particles is essential. Therefore, there is a need for coupling particle and wave transport simulations. This is important not only for the SEP transport itself but also for the particle acceleration at shocks, i.e. in studies of the foreshock evolution. We have developed such a code in the framework of the SPACECAST EU/FP7 project, based on the Monte Carlo approach with the goal of implementing the full resonance condition of particle scattering. Here we present details of the code, compare the results of our calculations with those obtained with the previous particle transport codes, and discuss the future implementation of the method.

The Australian Empirical Real Time Regional Ionosphere Model

Francis, Matthew; Terkildsen, Michael; Bouya, Zahra
IPS Radio & Space Services

We present the development of a data driven model of the Australian regional ionosphere for space weather operations. IPS Australia currently produces a regional real time TEC map using GNSS and a real time foF2 map using ionosondes. We will describe the development of a single unified assimilative, empirical real time model combining these and other data sources. Our approach is regional and data driven. The comparison to physics based models will be discussed along with the potential for forecasting regional using empirical approaches.

Advances on the real time Forecasting Tool for hmF2 coupling quiet and disturbance hmF2 Models.

Blanch, E.[1]; Altadill, D.[1]; Torta, J. M.[1]; Magdaleno, S.[2]
[1]Ebre Observatory URL-CSIC; [2]Atmospheric Sounding Station "El Arenosillo", INTA

The quiet behavior of the ionospheric electron density peak height of the F2 region, hmF2, has been evaluated from average electron density profiles and analytically modeled by the Spherical Harmonic Analysis (SH) technique. The quiet SH hmF2 model is bounded to the local time, season and solar activity, and it provides better performance than current International Reference Ionosphere (IRI) model does. The response at mid latitude of the hmF2 to the intense geomagnetic storms has been investigated and the height disturbance, ΔhmF2, has been modeled in relation to the local-time, season and bounded to the conditions of the interplanetary magnetic field. Coupling both above models, the quiet hmF2 and disturbance ΔhmF2, a potential forecasting tool for hmF2 has been developed. Performance of this tool has been evaluated at sub-auroral latitudes in the Sourthern Hemisphere. Results show that the forecasting tool for hmF2 predicts meaningfully well the uplift in hmF2 for several geomagnetic storms that occurred in the present solar cycle.

Space Weather global-to-local observational Asset

Blanch, E.; Torta, J. M.; Altadill, D.; Segarra, A.; Marsal, S.; Curto, J. J.
Ebre Observatory URL-CSIC

Space Weather is not a recent field, but being our daily life relying more and more on infrastructures sensitive to the Sun activity, accurate knowledge and forecasting tools are essential. In this paper we present an interdisciplinary study of the effects of solar activity on the Earth's environment, specifically the effects on the geomagnetic field and the ionosphere. A timeline of effects occurred on the Earth produced by one of the firsts relevant events of the present solar cycle (24-25 October 2011) will be given. We have analyzed solar wind shockwave from satellite data, compared observed geomagnetic variations with those obtained from the TIEGCM model fed with field aligned current data from AMPERE, and predicted geoelectric field and geomagnetically induced currents at the northeast of Spain. In addition we have analyzed ionospheric effects at Ebro Observatory and Port Stanley locations and compared it with the hmF2 disturbance model and with TIEGCM outputs. Physical mechanisms that relate those effects are also presented. On the basis of the experience gained with this study we attempt to design a practical space weather global-to-local observational asset to be used in future major events.

Preliminary study of kinetic-hybrid Interlocking in a Multi Level Multi Domain (MLMD) Framwork

Restante, Anna Lisa; Innocenti, Maria Elena; Olshevskyi, Vyacheslav; Lapenta, Giovanni
KULeuven

The SWIFF consortium has the ultimate goal of coupling kinetic and fluid description to achieve computationally sustainable simulations of space weather related events. A first step towards such an objective is the coupling between fully kinetic and hybrid (kinetic ions, fluid electrons) models. We start from an exiting 1D Multi Level

Multi Domain (MLMD) Implicit Moment Method Particle in Cell code (Innocenti et al., [submitted]) which simulates on different levels a fully kinetic plasma. We perform a stability study of such a code and of an hybrid code (Brackbill, 1982).
The challenges which arise from simulating the refined level kinetically and the corse level with an hybrid code are addressed and tentative solutions are proposed.

The ESA Virtual Space Weather Modelling Centre - Phase 1

Poedts, Stefaan[1]; Lapenta, Giovanni[1]; Lani, Andrea[2]; Deconinck, Herman[2]; Fontaine, Bernard[3]; Depauw, Jan[3]; Mihalache, Nicolae[3]; Heynderickx, Daniel[4]; De Keyser, Johan[5]; Crosby, Norma[5]; Rodriguez, Luciano[6]; Van der Linden, Ronald[6]; Jiggens, Piers[7]; Hilgers, Alain[7]
[1]CmPA/KU Leuven; [2]Von Karman Institute; [3]Space Applications Services; [4]DH Consultancy; [5]BISA; [6]ROB; [7]ESA

The ESA ITT project (AO/1-6738/11/NL/AT) to develop Phase 1 of a Virtual Space Weather Modelling Centre has the following objectives and scope:

1. The construction of a long term (~10 yrs) plan for the future development of a European virtual space weather modelling centre consisting of a new 'open' and distributed framework for the coupling of physics based models for space weather phenomena;
2. The assessment of model capabilities and the amount of work required to make them operational by integrating them in this framework and the identification of computing and networking requirements to do so.
3. The design of a system to enable models and other components to be installed locally or geographically distributed and the creation of a validation plan including a system of metrics for testing results.

The consortium that took up this challenge involves: 1) the Katholieke Universiteit Leuven (Prime Contractor, coordinator: Prof. S. Poedts); 2) the Belgian Institute for Space Aeronomy (BIRA-IASB); 3) the Royal Observatory of Belgium (ROB); 4) the Von Karman Institute (VKI); 5) DH Consultancy (DHC); 6) Space Applications Services (SAS). The project started on May 14 2012 and will take 24 months for completion. A status report will be given incl. the results of the Round Table meeting (September 2012) with the Science Advisory Team (SAT). The SAT consists of space weather model developers.

Predicting auroral Absorption from the Epsilon Parameter

Ogunmodimu, Olugbenga; Farideh, Honary
Lancaster University

The daunting task of developing a true predictive model that can serve space weather community has drawn huge motivation from the availability of solar, heliospheric and near-Earth data that are reliable and well calibrated. Past works have shown that for prediction purposes, a relationship linking geomagnetic activity with absorption for a given local time and latitude is desirable. Some of the authors [e.g Hargreaves, 1966; Kavanagh et al, 2004] are clear on the use of geomagnetic activity indices rather than solar activity indices as the building block of a predictive module. Fundamentally, the solar wind and IMF play important roles in shaping the magnetosphere and transferring energy and momentum into it. Some of the energy is passed to the electrons that precipitates to the ionosphere and causes radio absorption. Also, a near accurate parameter known for quantifying the energy transfer from the solar wind into the magnetosphere is the Akasofu epsilon parameter which comprise of a viscous and a merging terms. In this work, we perform a post-event correlation analysis of riometer absorption data and use the Akasofu epsilon parameter for the coupling coefficient. . The values of solar wind parameters used [solar wind velocityi^1/4 Vi^1/2_x, the IMFi^1/4- Bi^1/2_x ,B_y,B_z, and the solar wind proton number measured in GSM coordinate] obtained at the L1 point are from the OMNI data, time delay is taken to account for the propagation of the solar wind to the nose of the magnetosphere as given by Spencer et al., [Spencer et al., 2007]. Absorption values are from the Kilpisjarvi riometer station. The aim is to be able to predict absorption based on epsilon parameter.

Dipolarization Front at Reconnection Point in 3D PIC Simulations

Vapirev, Alexander[1]; Lapenta, Giovanni[1]; Markidis, Stefano[2]
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Massively parallel numerical simulations of magnetic reconnection are presented in this study. Electromagnetic full-particle implicit code iPIC3D is used to study the dynamics and 3D evolution of reconnection outflows. Such features as Hall magnetic field, inflow and outflow and diffusion region formation are very similar to 2D PIC simulations. In addition, it is well known that instabilities develop in the current flow direction or oblique directions. These modes could provide for anomalous resistivity and diffusive drag and can serve as additional proxies for magnetic reconnection. In our work the unstable evolution of reconnection dipolarization fronts are studied. Reconnection configuration in the absence of guide field is considered. Our study suggests that the instabilities lead to the development of finger-like density structures on ion-electron hybrid scales. These structures are characterized by a rapid increase of the magnetic field, normal to the current sheet (Bz). A small negative dip in Bz component is observed in the region ahead of the dipolarization front. Oscillations with period of ~45sec mainly in the magnetic and electric fields and the electron density are observed several minutes ahead of the dipolarization front which is consistent with recent THEMIS observations. The instabilities form due to fact that the density gradient inside the dipolarization front region is opposite to the direction of the acceleration Lorentz force. Such density structures may possibly further develop into larger-scale Earthward flux transfer events during magnetotail reconnection.

The Magnitude and Effects of Extreme Solar Energetic Particle Events

Jiggens, Piers; Chavy-Macdonald, Marc-Andre; Santin, Giovanni; Menicucci, Alessandra; Evans, Hugh; Hilgers, Alain
ESA/ESTEC

The solar energetic radiation environment is an important consideration for spacecraft design and spacecraft missions planning. To establish the environment specification a probabilistic, statistical model is used. For high confidences and short mission durations, such as those required for manned space missions, a single event often dominates the time series with the vast majority of the flux being delivered in a matter of days. Such extreme events can have catastrophic effects on spacecraft and their crew.

As part of a recent ESA activity the SEPEM (Solar Energetic Particle Environment Modelling) system was created allowing users to define energetic proton environment models and effects as a function of confidence level with a range of distributions and methods which may be applied to carefully processed data. This system has been used to establish the 95% confidence level SEP event for a 9-month manned mission in near-Earth interplanetary space. The energy range has been extrapolated to cover particles up to 1 GeV as these higher energies are very important when considering heavily shielded spacecraft. The environment model output has been compared to the well-known large August 1972 and October 1989 SEP events which are comparable in size to that which the approved SEPEM model predicts. The expected total ionising dose (TID), non-ionising dose (TNID), the peak fluxes behind the shielding and dose in humans have been calculated as a function of shielding thickness have been calculated using GEANT4 tools such as MULASSIS, SSAT and GRAS. We present the results of these studies. The results have been compared to the current ECSS guidelines where appropriate.

Finally this analysis has been performed for the environment determined by an approximated absolute worst-case event thought to be comparable to the infamous 1859 "Carrington Event". This work will allow designers and planners to establish a reasonable baseline for the impact expected as a result of extreme SEP events of importance to human spaceflight and other future missions.

Satellite Anomalies and Space Weather: Observations and probability Models

Dorman, Lev
Tel Aviv University and IZMIRAN

Lev Dorman for Satellite Anomaly Team*. Results of the Satellite Anomaly Project, which aims to improve the methods of safeguarding satellites in the Earth's magnetosphere from the negative effects of the space environment, are presented. Anomaly data from the "Kosmos" series satellites in the period 1971-1999 are combined in one database, together with similar information on other spacecrafts. This database contains, beyond the anomaly information, various characteristics of the space weather: geomagnetic activity indices (Ap, AE and Dst), fluxes and fluencies of electrons and protons at different energies, high energy cosmic ray variations and other solar, interplanetary and solar wind data. A comparative analysis of the distribution of each of these parameters relative to satellite anomalies was carried out for the total number of anomalies (about 6000 events), and separately for high (5000 events) and low (about 800 events) altitude orbit satellites. No relation was found between low and high altitude satellite anomalies. Daily numbers of satellite anomalies, averaged by a superposed epoch method around sudden storm commencements and proton event onsets for high (>1500 km) and low (<1500 km) altitude orbits revealed a big difference in a behavior. Satellites were divided on several groups according to the orbital characteristics (altitude and inclination). The relation of satellite anomalies to the environmental parameters was found to be different for various orbits that should be taken into account under developing of the anomaly frequency models. The preliminary anomaly frequency models are presented. We analyze also main space weather factors caused satellite anomalies and develop models for their forecasting (mainly great SEP events and precipitation of "killed" electrons during great magnetic storms).

Keywords: Space weather; Satellite anomalies; Solar and radiation belts energetic particles; Magnetic storms

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Global Distribution of GPS cycle Slips during ionospheric Storms of different Intensity

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It is known that the quality of performance of global navigation satellite systems (GNSS) depends significantly on space weather and, in particular, on the ionospheric conditions. Variations of electron density can change propagation speed of radio waves, introducing a propagation delay for signals. Rapid fluctuations of the electron density may cause cycle slip in carrier phase tracking. Very rapid fluctuations in the signal strength, ionospheric scintillations, can result in significant values of positioning error.
The most drastic perturbations in the ionosphere are known to occur during geomagnetic storms. The latter trigger, in particular, occurrence of intensive ionospheric irregularities and of gradients of electron density, and consequently, cause errors in performance of GNSS. In this work, we analyze global distribution of GPS cycle slips and of GPS positioning errors during ionospheric storms of different intensity. For our analysis we used data of GPS receivers from global networks IGS (ftp://garner.ucsd.edu) and UNAVCO (ftp://data-out.unavco.org). The total number of stations varied from 900 to 2000, depending on an event. The cycle slips were calculated from RINEX files for all satellites and for each GPS frequencies L1 and L2. The positioning errors were calculated as standard deviation between the known precise coordinates of a ground-based GPS receiver and coordinates computed by a receiver at each moment of time. Our analysis shows that the total number of GPS slips is higher during stronger ionospheric perturbations. Apart from the global distribution, we estimate regional contribution as well as day-night contribution. We expect that further developments in this direction will increase the possibility to forecast the GPS operation accuracy based on the input geophysical data, such as index of geomagnetic activity Dst and intensity of interplanetary magnetic field at the beginning phase of during geomagnetic storms of different intensity.
The work is partly supported by the French Space Agency (CNES), and partly by the Russian Federation President Grant ĐœĐš-2194.2011.5 and by the grant of the Ministry of Education and Science of the Russian Federation (projects 14.740.11.0078 and 16.518.11.7097).

Solar heavy ion worst-hour Flux Models used for single event effect Calculations at Geostationary Orbit

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Solar energetic particle events constitute a real threat for electronics on board operating satellites, especially during the maximum activity phase of the solar cycle. In this study, we constructed solar heavy ion worst-hour flux models and evaluated the effect of such strong radiation on electronic components in terms of Single Event Effects (SEE). Our study is performed on an electronic component in geostationary orbit.

First, we constructed worst-hour proton and heavy ion flux models for 10 major Solar Energetic Particle (SEP) events of Solar Cycle 23 using proton measurements from GOES and heavy ion measurements from ACE/SIS. The chosen SEP events are: July 14 2000, November 9 2000, April 15 2001, September 24 2001, November 4 2001, October 28 2003, October 29 2003, January 17 2005, January 20 2005 and December 13 2006. Estimated energy spectra cover energies from 5 MeV to 20 GeV for protons and heavy ions from helium to nickel (Z = 28). ACE/SIS data for 14 ions were processed and bad data were excluded from the study. Worst-hour energy spectrum profiles for the remaining Z≤28 heavy ions were defined by using solar abundance ratios.

To evaluate the effect of such environments on satellite operations in terms of SEE at component level, we used a typical geostationary satellite geometry. We performed a sector analysis calculation to estimate the shielding provided to an electronic component inside an on-board equipment. The output sector analysis file was used to estimate the Linear Energy Transfer (LET) spectrum for each SEP event model. Finally, SEE rates were estimated for each environment model.

Outputs are compared with results obtained using CREME96, the standard model recommended by ECSS for predicting worst-case solar heavy ion fluxes.

Impact Analysis of GPS signal Reception by space Weather

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The ionosphere can be the largest source of error in GPS positioning and navigation. When GPS signals pass straight through the ionosphere, they suffer a time delay as a result of the presence of so many free electrons. This typically results in positional errors of few meters, which can increase to tens of meters under extreme ionospheric conditions. Amplitude fading and phase scintillation by small scale irregularities in electron density of ionosphere can cause cycle slip or loss of carrier lock in GPS receiver.

Bursts of energy from the Sun on microwave radio frequencies can disrupt GPS signal reception. Solar radio burst can degrade Signal to Noise Ratio (SNR) of receiving GPS signal cause loss of carrier lock in GPS receiver also.

In this paper we investigated how space weather such as ionosphere and solar radio burst can degrade GPS signal reception, and propose mitigation methods for single frequency GPS receiver.

Improving radiation belt Models with an Emphasis on the slot Region

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We present an ongoing effort to improve models of the inner and outer radiation belts with European radiation monitor data. Our effort focuses on the slot region, where existing models are still poor. However, the activity covers all radiation belt regions - except for the outer part of the outer radiation belt - in order to address satellite orbits from typical low-altitude polar orbits to the medium earth orbit of the Galileo navigation constellation.

MAARBLE- Standard particle Data-Base to be used for Data Assimilation

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One objective of MAARBLE project ("Monitoring, Analyzing and Assessing Radiation Belt Loss and Energization"), which is being implemented by a consortium of seven institutions (five European, one Canadian and one US) with support from the European Community's Seventh Framework Programme, is to select and collect European and US particle data sets along different orbits to further perform optimal data assimilation with the Salammbô code and a ensemble Kalman filter. A primary list of missions envisaged so far is XMM/ERMD, INTEGRAL/SREM, PROBA-1/SREM, GIOVE-B/SREM, Cluster/RAPID, THEMIS/SST, Polar/CEPPAD and GOES/SEM. When available in the public domain, the instrument response function is collected and provided as well. Particular effort is devoted to SREM data processing using the Singular Value Decomposition technique to derive smooth proton and electron fluxes. We present here the status of this database where all data sets are standardized into a unique data format following PRBEM international standards.

Space Weather and Particle Effects on the Orbital Environment of PROBA2

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Data from the EUV imager SWAP and UV/EUV radiometer LYRA on board the PROBA2 spacecraft are regularly affected by space weather conditions along the spacecraft's orbital path. While these effects are generally removed from calibrated data intended for scientific analysis, they provide an interesting opportunity to characterize the evolution near-Earth space environment as the result of changing space weather conditions. Here we present an analysis of these space weather effects on PROBA2 observations and some conclusions about both the long-term evolution of the inner magnetosphere and short-term events driven by the active sun.

Status of Degradation Onboard PROBA2

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Since the satellite was launch on 2 November 2009, the two solar instruments onboard PROBA2 (http://proba2.sidc.be), had to cope with the effects of degradation at various levels. LYRA, a UV-EUV Radiometer, is the most affected, the four channels of its nominal unit being overlaid by polymerized contaminant. SWAP, an EUV imager, was rather impacted by side-effects of the spacecraft temperature evolution. The various degradation processes perturbing SWAP and LYRA are listed and illustrated, as well as the strategies that have been set up to palliate their effects (operational strategies, baking-out, software correction ...).

Radiation Belts Activity Indices and Solar Proton Event Alarm on CRATERRE Project Web Site

Lazaro, Didier; Boscher, Daniel; Bourdarie, Sebastien
ONERA

In the framework of the ONERA/CNES CRATERRE project, two Radiation Belts Activity Indices and one Solar Proton Event Alarm are developed for post events analysis with less than two days of delays. Exploitation of available data in IPODE (Ionising Particle Onera Data base) allows to define two Radiation Belts Activity indices deduced from daily average fluxes at L=4 using POES/SEM2 electron channel >300keV and JASON2/ICARENG electron >1.6MeV fluxes. For both indices, four classes of activity are settled : quiet, active, very active and extreme. In the same way, a Solar Proton Event Alarm is deduced from POES/SEM2 proton channel >75MeV flux measured above the outer edge of the proton radiation belt. Hourly, solar flare flux level is considered relative to a predefined threshold to determine three alarms: no event, small and large events. Both indices and alarm are plotted over the last 30 days Craterre web site and is updated every days.

Integrating data Collection and distribution Services with physical Models for near real time Forecasting in SPACECAST

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Solar activity can trigger sporadic bursts of energetic particles in the solar wind and increase the number of high and low energy particles trapped inside the Earth's radiation belts. These cause damage to satellites and are a hazard for manned spaceflight and aviation. They are difficult to predict due to uncertainties over the basic physical processes, and the need to access reliable data in real time.

The SPACECAST project (European Union Framework Programme 7 Project 262468) aims to protect space assets from high and low energy particles in the electron radiation belts and during solar energetic particle events by developing European dynamic modelling and forecasting capabilities.

SPACECAST uses a MySQL database server (using the ESA Open Data Interface under licence) operated by DH Consultancy to collect magnetic indices, solar wind parameters and GOES particle fluxes in near real time, and combines this with web services to distribute the data to model servers at NERC/BAS, ONERA and FMI, where model runs are executed to obtain forecasts of high and low energy electron fluxes in the radiation belts. The model results are collected by the DH Consultancy server, post-processed and displayed on the SPACECAST web site (http://fp7-spacecast.eu/) in the form of panel plots, movies and alerts (including a satellite risk index for GEO deep dielectric charging). All processes are fully automated and run at hourly intervals.

The model outputs and forecasts include the instantaneous and forecast (over 1, 2 and 3 hours) high energy electron flux and daily fluence, and mappings of the low energy electron flux throughout the radiation belts. The forecast products are continuously validated using metrics such as skill score and RMSE plots, which are also displayed on the web site for peer review of the product quality.

During the next phases of the project, modelling of solar energetic protons and a service to calculate radiation effects will be added. In addition, alert services are being defined which can be tailored by registered users.

The DTM2012 thermosphere Model in the Framework of the FP7 Project ATMOP

Bruinsma, Sean
CNES

Atmospheric density models are used in satellite orbit determination and prediction programs to compute the atmospheric drag force, as well as in upper atmosphere studies. They represent temperature and (partial) density as a function of altitude, latitude, local solar time, day-of-year, and parameters related to the state of atmospheric heating due to solar EUV emissions and solar wind. One of the objectives of the Advanced Thermosphere Modelling for Orbit Prediction (ATMOP) project is developing a new semi-empirical thermosphere model that is more accurate than presently available models. DTM2012 is the first model; the second revised model will be delivered in Fall 2013.

DTM2012 is fitted to the full CHAMP high-resolution density data set, as well as GRACE density data for 2003-2010 in particular. High altitude density data as well as the Dynamics Explorer-2 and Atmosphere Explorer A/C/E mass spectrometer data have also been used. GOCE density data, at 255 km altitude, will be assimilated as soon as possible; they have been used in the validation. Daily-mean densities in the 200-500 km altitude range

from the Air Force have also been used for validation only.
This presentation will describe the new model and its new interface, and its performance compared to the pre-ATMOP DTM2009, as well as the CIRA reference model for satellite drag computations, JB2008.

Cluster and Double Star DWP single event Upsets: Effects of radiation Belts and galactic cosmic Ray Flux.

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The Cluster and Double Star Digital Wave Processor instruments experience radiation induced single event upsets in the memory devices. The rate at which these events occur has been recorded as a function of L value, and over the duration of the two missions. The statistical study shows strong dependence of relative effects upon L values. At low L values the single events upset rate closely follows the flux of the trapped energetic particles. However at high L values any dependence upon L value disappears and the upset rate exhibits a strong correlation with the galactic cosmic ray flux as recorded by a neutron monitor on the ground. Methodology for a mitigation of single upset effects that are based on the forecasting tools are presented.

Relativistic Electron Fluxes and Dose Rate Variations on Manned Satellites - "Mir" and International Space Stations

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Space Research and Technology Institute-Bulgarian Academy of Sciences

The paper presents observations of relativistic electron precipitations (REP) on the "Mir" and International Space Station (ISS) obtained by 4 Bulgarian-built instruments flown in 1989-1994, 2001 and 2008-2010. The first data are from the Liulin instrument flown 1989-1994 inside the Russian "Mir" space station. This period, being in high solar activity, is dominated with large number of solar proton events (SPE) and magnetic storms. These conditions generate large number of inner magnetosphere enhancements, including the formation of the "New radiation belt" at low L values after the SPE on 22 March 1991. This feature was observed by us till the middle of 1993. The second period of observations is in May-August 2001 inside the USA laboratory module of the ISS. Next the time profiles of the REP-generated daily fluences and the absorbed doses outside of ISS during the period February 2008 - August 2010 are analyzed in dependence of the daily Ap index and compared with the daily relativistic electron fluence with energies of more than 2 MeV measured by the GOES. The REP in April 2010, being the second largest in GOES history (with a >2 MeV electron fluence event), is specially studied. These long-term observations support the conclusion that REP is common phenomena on manned satellites. REP and the dose rates variations generated by them inside and outside the manned satellites have to be specially studied because of the space radiation risk which they induced to the crew members during extravehicular activities.

Data assimilative Modelling of Plasmasphere and Space Weather Events in the PLASMON Project

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The PLASMON FP7-Space (A new, ground based data-assimilative model of the Plasmasphere - a critical contribution to Radiation Belts modeling for Space Weather purposes) project develops a new data assimilative model to provide near real-time monitoring capability of the densities in the Plasmasphere for modelling Space Weather events. The data assimilative modeling is based on two existing global measuring networks, AWDANet measuring VLF whistlers and EMMA measuring ULF FLRs. A third network, AARDDVARK monitors precipitating particles from the Radiation Belts through VLF signal perturbations. The ground based density data are integrated into a data-assimilative model of the Plasmasphere, which is in turn used to compare model predictions on relativistic electron precipitations with measured data.
The expected final model can serve as a basic tool to monitor the local space environment as well as key data for modelling generation and loss of energetic charged particles. The paper describes the latest advances of the project.

The Carrington Event from 1859 : Impact on Communications and Economy, Extrapolation to 2012.

Muller, Christian
B.USOC

The beginning of September 1859 was the occasion of the first and unique observation of a giant solar white light flare, auroral displays were observed at low latitudes and geomagnetic observatories recorded an exceptional storm. The intention of this paper is to review the impact of the event on the telegraphic network as it was described by various authors at the time including Adolphe Quételet in Brussels. The techniques used by the operators to mitigate the effects will be described. An attempt to quantify the phenomenon will be made in terms of induced currents on the telegraphic lines. The economic consequences at the time will be assessed from a press review.

The potential consequences on current power and communication transmission systems will be analysed using the experience of previous events like the well documented Halloween event of November 2003. The effectiveness of the current countermeasures used to shield electronic circuits against Single Event Upsets caused by cosmic rays or even by a potential belligerent will be compared against the properties of a Carrington like event.

JUICE Jupiter Mission Radiation Environment and Variability

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ESA

ESA has selected the JUICE mission to the moons of Jupiter as a future "large" class science mission. A major engineering, and therefore cost, driver is radiation hardness assurance. The Jovian radiation belts are well known to be very harsh in terms of ionizing particles, with little in]situ data available. Empirical models of the environment have been established successively using Pioneer, Voyager and Galileo data; the most extensive data to date are from Galileo. Model uncertainties lead inevitably to design risks for the spacecraft and to imposition of appropriate radiation design "margins" to mitigate this risk. Uncertainty stems in large part from uncertainties in the underlying data, due either to the design and calibration of the instrument or the representativeness of the data to the mission under investigation. Although some radiation environment models use "confidence levels" to mitigate this latter uncertainty, these have to be used with caution. They are normally based on the scatter of instantaneous measurements and so do not reflect the probability distribution of time-integrated fluxes (fluences) over trajectories, of relevance to dose estimation.

We present the JUICE radiation environment and examine variability of the environment encountered on segments of the Galileo trajectory passing regions of importance to the JUICE mission. JUICE will reach Jupiter at earliest in 2030 and will spend 3 1/2 years exploring the Jupiter system before "disposal" on Ganymede. In that time it will fly by Europa twice, encountering the most challenging instantaneous radiation environment of the mission, and orbit Callisto and Ganymede. The resulting mission radiation dose can reach megarads with shielding typical of Earth-orbiting spacecraft . More shielding will clearly be necessary and the shielding thickness determines the particle energies in the environment of importance to the total dose and other hazards (internal electrostatic charging). With a 1cm aluminium shield, electrons with initial energy around 10MeV are most important while Increasing the shielding to 2cm shifts the important energies to around 20MeV.

The analysis of variability examines data from the 3 most useful instrument channels of the Galileo EPD instrument. Unfortunately these channels have very broad responses to electrons, making derivation of electron spectra difficult. Nevertheless, the Galileo trajectory passed repeatedly through regions that will be encountered by JUICE, allowing derivation of fluence variations as a basis for proposing engineering margins. Given the importance of radiation effects to the mission, it is also planned to improve the methodology for radiation shielding analysis to be applied through the project lifecycle to allow collaborative iterations in an efficient manner, and also to embark as part of the platform equipment a customized radiation monitor targeted at measuring energetic electrons with good resolution in the energy range of concern.

First Reconstruction of the solar Irradiance out of the ecliptic Plane.

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The solar spectral irradiance (SSI) is a critical input for space weather applications but also to quantify human-driven climate change. Direct observations of the SSI started in the late 1970's, showing solar cycle variations that range from a fraction of a percent in the visible range, to several percent or more in the UV. The latter is particularly important for the specification of the thermosphere/ionosphere system.

To day, all SSI observations and modelling efforts have concentrated on one unique vantage point only, which is the terrestrial one. An important, but so far unanswered question is: how does the SSI and its variability look like from other vantage points, i.e., outside of the ecliptic plane? This question is relevant for space exploration (e.g. for missions such as Solar Orbiter), for the understanding of the solar radiative output, but also for comparing the Sun to Sun-like stars. This raises a second, and more fundamental question: how does the solar luminosity vary in time? Due to a lack of quantitative estimates, this has never been assessed.

Here, we use a semi-empirical irradiance model that relies on solar surface magnetism to reconstruct the total solar irradiance (TSI). For the first time, we estimate the TSI for the full 3D heliosphere, from June 2010 till today. From this, we are able to derive the solar luminosity.

Our results show that observers with different orbital inclinations experience various levels of irradiance, but the variability in the TSI remains comparable to that observed at Earth. Significant differences between different vantage points arise when there are hemispheric asymmetries in solar active regions. These effects are important for future missions that will go out of the ecliptic plane. However, they are not sufficient to drive observed millenial climate variations through orbital inclination changes. The variability of the luminosity, which differs from that of the TSI, will be discussed and recent results on the 3D reconstruction of the SSI (and not only the TSI) will be presented.

Modelling and pPevision of the Fluctuation of the Space Weather due to the solar Wind and cosmic ray radiation Effects

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Key Words : Solar Activity, Géomagnetism, Space Weather, Modelling simulation, Epidemies

Background : According to their energy , cosmics and solar radiations reach the < Space Weather < around the surface of the earth and have consequences on living organisms and thus their immune response and emergence of epidemies (1,2)
The particles associated with solar flares have energy ranging from a few tens of Kev to GeV
Most cosmic radiations, coming from outside the solar system, have energies ranging between 100 MeV and 10 GeV and particles flux with energies below about 10 GeV have significant anticorrelation with the 11 years cycle Solar activity. Several authors have highlighted a link between, solar flares, space weather, cellular metabolism and immune response

Method : To taking account the relation between the space radiation and the biosphere must be modelling: -interaction with the molecules of atmosphere itself -interaction with the living organism (free radical DNA)

And use:

SADT : Structural Analisys and Design Technic Method this method consists to represent any process by functional blocks which describe them according to a specific equation

To descibe each process of functional block quantitatively, it is know that excellent equation type describing them is PID equation (Proportional, Integrative, Derivative) of the form '3):
$Y(t)=k1\ X(t) + k2 \int X(t)\ dt + k3\ d(X(t))/d(t)$
Parameter of each independent variable correspond to each coefficient determined by the regression.

Genesyx is a knowlwedge engineering system: in which each block is interconnected following the DATA in a logical way to form a global model of interraction giving a quantitative and qualitative results(3).

Data: Taking in consideration the solar and cosmic particles(proton, electron, Gamma photon and cascads of secondary particles (gerbes d'Auger), Geomagnetic Index (K, Kp Kpa), (4) for biological parameters mortality (D(t)), due to influenza some relations has been established (5).

$Kp(t) = 0{,}0012W^2(t) + 0{,}4513\ W(t) + 161{,}21$, ($R^2 = 0{,}1064$)

$D(t) = 20{,}7\ Kp(t-60) + 7{,}07\ Kp(t-61) - 226{,}36$ ($R = 0{,}26$, $n = 102$ week)

Conclusion and discussion: We found a similarity between occurrence of epidemic and solar effect during epidemic and pandemic period. The immune system is an important regulatory mechanism affected by natural cycle (10-13 years) of the sun (6) .The action of electromagnetic field around 2,8GHz on viruses mutations,may perhaps have break DNA, gene expressions. We have probably an immune depression and/or viruses mutations due to space factors and then an indirect incidence on epidemic diseases. The theory of Planetary Modulation of the Solar Activity (7)permits prevision of the occurrence of sunspots and pandemics. It is possible to forecast approximate period of probable beginning of the next surge of an epidemic.

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Modeling Atmospheric Energy Deposition (by energetic Ions)

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The structure, dynamics, chemistry, and evolution of planetary upper atmospheres are in large part determined by the available sources of energy. In addition to the solar EUV flux, the solar wind and solar energetic particle (SEP) events are also important sources. Both of these particle populations can significantly affect an atmosphere, causing atmospheric loss and driving chemical reactions. Attention has been paid to these sources from the standpoint of the radiation environment for humans and electronics, but little work has been done to evaluate their impact on planetary atmospheres. At unmagnetized planets or those with crustal field anomalies, in particular, the solar wind and SEPs of all energies have direct access to the atmosphere and so provide a more substantial energy source than at planets having protective global magnetic fields. Additionally, solar wind and energetic particle fluxes should be more significant for planets orbiting more active stars, such as is the case in the early history of the solar system for paleo-Venus and Mars. Therefore quantification of the atmospheric energy input from the solar wind and SEP events is an important component of our understanding of the processes that control their state and evolution. Such modeling has been previously done for Earth, Mars and Jupiter using a guiding center precipitation model with extensive collisional physics. Currently, this code is only valid for particles with small gyroradii in strong uniform magnetic fields. There is a clear necessity for a Lorentz formulation that can perform calculations for cases where there is only a weak or nonexistent magnetic field that includes detailed physical interaction with the atmosphere (i.e. collisional physics). We show initial efforts to apply a full Lorentz motion particle transport model to study the effects of particle precipitation in the upper atmospheres of Venus, Mars, and Titan. A systematic study of the ionization, excitation, and energy deposition is conducted including a comparison of the influence relative to other energy sources (namely EUV photons) and previous efforts using the guiding center approximation.

New instrument Concept for Reconstructing the solar UV Flux for planetary space weather Applications

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The specification of the local space weather conditions of a planet becomes today an important parameter for modelling issues, especially for thermosphere/ionosphere modelling. Various planetary space weather applications then require a continuous and radiometrically calibrated monitoring of the solar spectral irradiance in the UV, especially to better understand how it directly affects the thermosphere/ionosphere system of the considered planet/moon. As of today, all solar UV observations are made either with broadband radiometers or with spectrometers. All these instruments suffer from degradation and are facing the problem of in-flight calibration. As a consequence, most applications that require continuous and long-term observations rely instead on a variety of solar proxies that partly mimic some of the spectral bands. The search for more robust instrument concepts therefore is an issue of considerable importance.

We propose a solution which is expected to overcome, at least partially, these problems. We propose here a new approach based on the idea that it is not necessary to measure the all spectrum but that a few bands suffice for retrieving all the other wavelengths. Five spectral bands in the UV are found to be sufficient for retrieving the full solar UV spectrum with an accuracy that is comparable to that of present spectrometers. Besides, we consider here wide band gap materials instead of silicon for the photodetectors, which are suited for very harsh environments such as the Jovian system. Finally, those new detectors select directly the desired spectral range making front filters, which can contribute to in-flight degradation, useless. With a small weight and a low telemetry, this new instrumental concept might be an interesting asset for planetary missions, such as the JUICE mission.

Detecting Solar energetic particle Events with NMDB

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In the Neutron Monitor database NMDB, a project that was started with FP7 funding, Cosmic Ray observations from ground based Neutron Monitors of over 30 stations worldwide are combined in real-time. On May 17, 2012, this network detected the first ground-level enhancement (GLE = relativistic solar particle event) of the current solar cycle. The growing coverage of NM stations allows us to quickly determine spectra and intensities of earth-directed solar energetic particle events, which can be harmful to technology aboard spacecaft, radio communications and which create an enhanced radiation dose aboard aircraft. We will demonstrate the improved availability of real-time data and some of the data products that several participants of the NMDB project routinely create.

Anomalities of space weather Characteristics fixed by the space ionizing radiation monitoring System of Roscosmos

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The exploitation experience of space ionizing irradiation exposure on electronic components of engineering Monitoring System elements is discussed. The subjects considered are the space-borne control of TID effects on electronic components, the ground-based control of space weather characteristics and the ground-based space weather forecast station functioning.
The base component of space-born segment is the set of TID sensors, operating on MNOSFET dosinetry principle. More than 36 TID sensors were placed onboard more than 18 spacecraft at the circular orbit ~20000 km since October 2008. The analysis of the flight data in 2012 is presented. Anomalous increasing dose rate in March (in ~ 100 times) after big solar flare was observed. The TID sensor data were compared with the average dose rate from the International Space Station, with ELECTRO electron flux, with ground measurements of cosmic ray variations by Moscow Neutron Monitor and with GOES proton and electron flux data. An excellent agreement with TID sensor data and integral flux of GOES 2 MeV electron is observed. The ELECTRO, ISS and ground-level data also correlate with TID sensor data.
The anomalous on 07.03.2012 was predicted by the forecast station of Monitoring System. The proton flux increasing was predicted on the previous day. Modification of electron fluence forecast was carried out. Verification of electron fluence forecast showed a good correlation between forecast and experimental data. The absence of abrupt increasing of dose rate at the MEO during the solar flare with proton flux increasing and without electron flux increasing at the GEO is noted. The experimental dose rate data were compared to the calculated dose rate. The experimental and calculated dose rates differ from each other in the order of magnitude in several periods of time.

eHeroes Assessment of Radiation Exposure during future Missions to the Moon and Mars

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During the upcoming decades, all important worldwide space agencies are planning to undertake interplanetary travel outside the terrestrial magnetic field. Human and robotic missions are planned from scientific exploration to economic space endeavours. The FP7-funded project eHeroes (www.eheroes.eu) plans to address one of the greatest issues in space exploration: radiation exposure to the astronauts due to space weather.
The present work deals with an investigation of the radiation dose astronauts may receive during two of the most important missions, i.e. Moon and Mars colonization. Concerning the assessment, the missions are divided into many segments in order to take into consideration all the different radiation sources. The main radiation the astronauts are going to face are SPE – Solar Proton Events and GCR - Galactic Cosmic Rays, since the radiation belts around the Earth affect only a short exposure time.
Extensive use of SPENVIS is made to carefully assess typical expected mission doses for the Moon and Mars, breaking up the dose into the component during flight and the component during residence on the surface. Comparison has been made with previous published studies.
A key aspect of the mission planning and execution is the ability to immediately asses in real time the dose produced by a given space weather event. For this reason, eHeroes has developed a new analysis code, to be made available online on the eHeroes web site, which takes as input particle fluxes recorded by some specific satellites, such as ACE and GOES, and allows the user to choose some principal parameters related to shielding and geometric conditions. As output, the code gives the value of the effective dose and the ambient dose equivalent,

both expressed in Sievert, according to recent radiation protection protocols. This eHeroes tool can be refined to take into account details of future missions and can operate in real time to help the astronauts monitor and manage their radiation exposure.

Space Weather Research in Romania in the Frame of the COST Action ES0803

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The paper presents the main achievements of Romanian research in the Space Weather field during 2008-2012, related to the CA ES0803 objectives. The most powerful solar flares (spectral X class) producing "sunquakes" - a roughly circular surface ripple seen accelerating outward from the site of an impulsive flare, 20-60 min after the impulsive phase - were comprehensively analysed applying computational seismic holography to the MDI observations. This work has brought an explosion in the discovery of sunquakes in Solar Cycle 23 (SC 23), some from relatively small, M-class flares; it also resulted in an important sunquake database available online at: http://www.diana-ionescu.eu/sunquakes/sunquakes.html.

We have also studied the coronal mass ejections that produced major geomagnetic storms during the SC 23 and the CMEs which reached Earth during the interval 2007-2010 (STEREO era). A study of CMEs kinematics was performed. This was correlated with CMEs interplanetary manifestations and their geomagnetic effects, along with the energy transfer flux into magnetosphere (the Akasofu coupling function). Their in-situ signatures and the correlation with geomagnetic indices were also analysed and discussed.

High Speed Streams (HSSs) in the solar wind and their geoeffectivness during the solar cycle 23 were intensively analysed. A Romanian team set up a catalog of HSSs (http://www.spacescience.ro/new1/HSS_Catalogue.html) as well as a complex catalogues containing the geomagnetic storms and their solar and heliospheric sources during the peculiar SC 23 (1996-2008) (http://www.spacescience.ro/new1/GS_HSS Catalogue.html). These catalogs offer an useful database for the purpose of case analysis in order to improve the geomagnetic forecasts.

The studies of the long-term variability of the heliosphere-magnetosphere environment (using measured and reconstructed solar, heliospheric and magnetospheric parameters) were also performed and the European climate response to the solar/geomagnetic long-term activity was analyzed.

Our results in the WG3 of ES0803 (WG 3 Exploitation, Dissemination, Education, Outreach) are also reviewed. All this research in Space Weather field was supported by the Romanian scientific projects that are also here specified.

Photospheric and chromospheric Observations carried out with the Swedish Solar Tower

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We report on the evolution of sunspots and small scale features observed with the Swedish Solar Tower (SST) at extreme high spatial resolution (0.15"). We use spectropolarimetric data in the Fe I pair at 630.2 nm to study the behavior of the magnetic field in the penumbral region around a well developed sunspot. Interestingly, wide-band images show twisting motions of the penumbral filaments. Moreover, a comparison between two umbral regions with different number of umbral dots indicate a noticeable difference in their brightness and magnetic field strength. Brightenings in Ca II H line are also noticed in the small scale features analyzed, indicating the occurrence of transient phenomena in the chromosphere. We highlight the importance of these results in the framework of our comprehension of processes of interaction between plasma and magnetic field and, in a larger context, in Space Weather advance.

Field-aligned current Variations - Joule Heating and its Effects in the thermosphere-ionosphere System

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Despite modeling efforts, the thermospheric-ionospheric effects of field-aligned-current (FAC) variations at high latitudes are still not fully understood. There is still confusion between solar wind turbulence that indirectly enters the Earth's magnetosphere and FAC filaments produced by nonlinear or transient mechanisms. Large-scale FACs are, however, accompanied by FAC structures of smaller scale and filaments. While large-scale field-

aligned currents are modeled and simulated practically to their full extent, the physics of small-scale FAC and FAC filaments, which happen under both disturbed and quiet conditions, needs further theoretical and experimental considerations. These FACs of small-scale and/or filament structures are important due to their effective Joule dissipation in the thermosphere-ionosphere region. 3-D changes in the ion-temperature distribution, due to height varying electric field/FAC distribution, in the polar ionosphere as produced by the Joule heating process are modeled. As expected, FAC structures have variable distribution within the geomagnetic latitude range of 60°-85°. which strongly depends on the solar wind velocity, IMF orientation and Earth's dipole orientation at given moment.

This study provides possible rates of change in the ion temperature distribution with height depending on the spatial scales of the FAC structures in the auroral regions. Ion temperature distributions produced by FAC measured by CHAMP satellite are modeled and further tested on observations of ionosphere parameters conducted by EISCAT UHF/VHF radars on 30 June-02 July 2008. CHAMP data of field-aligned currents distribution and their dynamics at high latitudes are involved in this study. The effects on the thermosphere parameters at heights 200-400 km due to the ion temperature change are also envisaged.

Contribution of Cyprus to COST ES0803 Activities

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During the last four years, efforts in Cyprus have focused on establishing infrastructure to monitor the ionosphere and Space Weather (SW) effects on ionospheric characteristics. In addition, ionospheric modeling and model validation studies have been conducted in an effort to exploit ground-based (ionosonde) and space-based (LEO satellite) measurements over Europe. This presentation summarises these efforts and provides an outline of future projects as a result of collaborations through COST ES0803.

Thunderstorm Ground Enhancements (TGEs) - New High Energy Phenomena Originated in Terrestrial Atmosphere

Chilingarian, Ashot
Yerevan Physics Institute

Strong electrical fields inside thunderclouds give rise to the enhanced fluxes of high- energy electrons and, consequently, gamma rays and neutrons. During thunderstorms at mt. Aragats, hundreds of the Thunderstorm Ground (TGEs) comprising of millions of additional particles were detected at Aragats Space Environmental Center (ASEC) on altitude of 3200 m. Observed large TGE events allow for the first time to measure the energy spectra of electrons and gamma rays well above the cosmic ray background. The integral energy spectra of the electrons have exponential shape and extend up to 40-50 MeV. The recovered power-type gamma ray energy spectra prolonged up to 100 MeV. At lowest recovered energies (~2-3 MeV) the intensity of gamma rays over-performed cosmic ray background i1000 times, thus proving existence of the Relativistic runaway electron avalanche (RREA) process in the thunderstorm atmospheres. There are at least 6 effects manifested by the TGE:

- large fluxes of the electrons and gamma rays;
- neutron fluxes;
- short bursts of the electrons;
- depletion of the high energy muon flux;
- large negative near-surface electrical field;

depletion of the cloud-ground (CG-) lightning occurrences and enhancement of the intracloud (IC-) lightning occurrences.

The basis of our model is the creation of the lower dipole by forming mature Lower positive charged region (LCPR). When electrical field is above the critical value the electron-gamma ray avalanches sustain exponential growth of the avalanche particles. Simultaneously, the propagation of the lightning stepped leader is blocked and CG- lightning turns to IC-.

The long high-energy tail of the TGE gamma ray energy spectrum, as well as the depletion of high-energy muons can be explained by the modification of charged particle energy spectra in the strong electrical fields of the thunderclouds (without avalanche process).

Space Weather Products and Services provided by the Aragats Space Environmental Center (ASEC)

Chilingarian, Ashot
Yerevan Physics Institute

Numerous particle detectors and field maters located on the slopes of mountain Aragats and in Yerevan 24 hours 12 months are monitoring changing geophysical conditions. ASEC facilities monitor particle fluxes from sun, thunderclouds and Galaxy as we as magnetic and electrical fields, lightning occurrences, issue alerts and forewarnings on upcoming dangerous consequences of space and thunderstorms.

Following Space Weather information products are available:

- Continuous measurement and display of fluxes of different species of secondary cosmic rays with different energy thresholds and directions of incidence from ASEC and world-wide SEVAN networks;

- Continuous measurement and display of the geophysical information including geomagnetic field, near-surface electrical field, lightning occurrences of different types;
- Continuous measurement and display of the various meteorological parameters;
- Forewarning service on approaching sever radiation storm;
- Advanced visualization and analysis tools as WEB embedded products of ASEC portal.
Methodical & scientific results:
- Methodology of correcting time series on atmospheric pressure and daily wave effects;
- Methodology of disentangling mixture of secondary cosmic rays to charged and neutral particle fluxes;
- Methodology of classifying Interplanetary coronal mass ejections (ICMEs) and relating parameters of changing cosmic ray flux to parameters of ICME.
- Fundamental scientific results on the modulation of secondary cosmic rays in the interplanetary space and in the terrestrial atmosphere. Data analysis applications:
- Systematic accumulation of the raw scientific data accompanied by the necessary for understanding and including in integrated data set metadata;
- Continuous checking of the quality of data; calculation of short-term and long-term corrections due to aging of the particle detectors and electronics;
- Providing tools for the multiple comparisons of experimental and model data, choosing best models for now-casting and forecasting of dangerous consequences of space weather;
- A comprehensive post-analysis of the phenomenology for the physical modeling.

Geomagnetic Response to solar and interplanetary Disturbances

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The space weather discipline involves different physical scenarios, which are characterized by very different physical conditions, ranging from the Sun to the terrestrial magnetosphere and ionosphere. Therefore, development of a comprehensive model to explain the entire Sun-Earth chain is presently still far from completion. However, the effects of solar activity on our modern technological infrastructure have clearly demonstrated the need for accurate space weather services to address a broad spectrum of user needs. A key element for completion of this task is to push for advances in our knowledge of solar-terrestrial physics. Our work focuses on the geomagnetic response to solar and interplanetary disturbances. Besides their long-term evolution seen by several parameters used to characterise heliosphere-magnetosphere environment, we also will show some advances in knowledge of short-term responses of the terrestrial environment. The response to solar energetic events, the evolution of the ring current in both the main and recovery phases and achievements in modelling the coupling between magnetospheric and ionospheric activity are examples of some topics covered.

Electrical Response of auroral lower Ionosphere to Solar Wind during minimum and maximum Solar Activity

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Electric currents and fields in the lower ionosphere at auroral and high latitudes are produced by the solar wind (SW) influence to magneto-ionosphere and formation of field-aligned currents (FAC) and trans-polar potential difference. We study this type of coupling between cosmic factors and lower ionosphere, its dependency on solar activity, and the efficiency by solar minimum and maximum. This goal is realized by a numerical model CORIAEC (Cosmic Radiation Influence on Atmospoheric Electrical Circuit) developed by us of the electrical coupling of the middle and lower ionosphere (Tonev and Velinov, 2011; 2012). This model is based on the continuity equation for the density of the electric current. This equation is solved in the region of altitudes between 50 km (accepted as the lower boundary of the lower ionosphere), and 160 km (considered as the upper boundary of the dynamo region in which an effective closure of FAC takes place). The model domain comprises the geomagnetic latitudes higher than 45° in one of the hemispheres. Boundary conditions are used which represent the distributions of the ionospheric potential and FAC at altitude of 160 km at polar latitudes. At this first step the model uses a steady-state approximation. The source equation is solved numerically by the use of the finite volume method.

The factor of solar activity influences the electric characteristics in the auroral lower ionosphere by two ways: i) in a straight way, through variations of the characteristics of FAC and the trans-polar potential; ii) indirectly, by variations of conductivities in the middle and lower ionosphere. The conductivities in dynamo-region, and the ratio between transverse and field-aligned conductivity controls the downward penetration of the electric currents and fields; these conductivities are in right dependence on the solar activity. In opposite, the conductivity in the lower ionosphere, particularly below 80 km where the factor are the galactic cosmic rays (GCR), are in reverse dependence from the solar activity, due to modulation of GCR by SW. The comparison made by us by the use of the model between minimum and maximum solar activity shows that the electrical coupling between SW and lower ionosphere is more effective by maximum solar activity than during solar minimum. In solar maximum in the lower ionosphere are created much larger electric fields.

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Atmospheric Ionization Effects During Ground Level Enhancements 65 and 69 Due to Solar Cosmic Rays

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At present the contribution of proton nuclei of galactic and solar origin in a recent cosmic ray induced ionization models is highlighted. However the contribution of light and heavy nuclei to the ionization in the Earth's atmosphere and ionosphere is of a big interest, specifically during reach on heavy ions solar particles events. The ion production rate profiles in the atmosphere due to a major solar energetic particle event on 28 October 2003 and 20 January 2005 (Ground Level Enhancements GLE 65 and 69, respectively) produced by various solar nuclei, namely proton, Helium, Oxygen and Iron are explicitly obtained. The spectra of the nuclei are considered on the basis of GOES 11 satellite measurements and bibliographic data. In addition the Forbush decrease, i.e. the reduced galactic cosmic ray flux during GLE 69 is explicitly taken into account. A full Monte Carlo simulation of the cosmic ray induced atmospheric cascade is carried out with CORSIKA 6.52 code using FLUKA 2006b and QGSJET II hadron interaction models. The energy deposit of the nuclei in the atmosphere is obtained. The winter profile of the atmosphere is considered, which permits precise and realistic description of the event. The ion production rate is compared for different latitudes, namely for 40° N, 60° N and 80° N. The contribution of various nuclei of galactic and solar origin as a function of the latitude is widely discussed. The time evolution of obtained ion rates is presented. The ion production rates of the two GLE events are compared.

Electron Production by Cosmic Rays Simulated by CORIMIA (COsmic Ray Ionization Model for Ionosphere and Atmosphere) Code

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We improve our previous Cosmic Ray (CR) ionization rate model because it is important for investigation of the different space weather effects. The cosmic rays and UV radiation determine to a great extent the chemistry and electrical parameters in the middle and lower ionosphere. They create ozonosphere and influence actively the stratosphere ozone processes. But the ozonosphere controls the meteorological solar constant and the thermal regime and dynamics of the lower atmosphere, i.e. the weather and climate processes. CR influence dominates during the night and sunrise]sunset periods, because galactic CR are always bombarding the Earth atmosphere. The CR flux varies during the solar cycle in an opposite face to that of sunspots. This hypothesis of the solar-terrestrial relationships shows the way to a non]contradictory solution of the key problems of the solar-terrestrial influences.

The presented new version CR Ionization Model for the middle atmosphere and lower ionosphere is physical space weather model with fully operational implementations. CORIMIA (COsmic Ray Ionization Model for Ionosphere and Atmosphere) code is able to produce values of electron and ion production rates q(h) due to CR ionization in the Earth atmosphere for different altitudes (30 - 120 km), solar and geomagnetic activitiy (low, moderate and high), and atmospheric cut offs. Besides, the proposed CR model can determine the energy interval contributions for all groups of nuclei. The effects of galactic, solar and anomalous CR in the middle atmosphere can be computed with our model. We take into account the CR modulation by solar wind. In fact, CR determine the electric conductivity in the middle atmosphere and influence the electric processes in it. In

this way CR introduce the solar variability in the terrestrial atmosphere and ozonosphere.

A new analytical approach for CR ionization by protons and nuclei with charge Z in the lower ionosphere and the middle atmosphere is developed. For this purpose, the ionization losses (dE/dh) for the energetic charged particles according to the Bohr-Bethe-Bloch formula are approximated in different energy intervals (five ionization losses intervals, one charge Z decrease interval and five intermediate coupling intervals). On this way we increase the number of the approximation intervals and with this new improvements the model accuracy becomes better. Besides, the real physical process is now described more adequately. For example the charge decrease interval contribution at height of 50 km reaches almost 20% from the corresponding electron production rate value. The intermediate interval contribution at 35 km is about 10%. So these new interval calculations may be important for the model results.

Electron production rate profiles q(h) are determined by the numerical evaluation of a 3D integral with account of cut-off rigidities. The integrand in q(h) gives the possibility for application of adequate numerical methods - in this case Wolfram Mathematica 7 and Maple 14 interactive procedures, for the solution of the mathematical problem. The contributions of the different approximation energy intervals can be presented in graphical mode. In this way the process of interaction of CR particles with the upper and middle atmosphere are described much more realistically. The full CR composition is taken into account. The COSPAR International Reference Atmosphere CIRA'86 is applied in the computer program for the neutral air density and scale height values.

The structure of the proposed model CORIMIA allows its decomposition in several submodels: submodel for GCR, submodel for SCR, submodel for ACR. Each submodel is further decomposed in submodels with account to the different characteristic ionization losses energy intervals. In this case we take into account the physical meaning of the undependent variables subintervals. The ionization losses function is calculated taking into account the energetic particles charge decrease interval. The energy intervals investigation takes place according to the goal of the user of the model with respect to accuracy and interval types.

Multi Dagnostics of dynamic large scales Ionospheric Structures

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In order to develop a quantitative model of evolution high latitude ionospheric structures during geomagnetic disturbances the analyses of particle and waves in situ measurements and TEC data and RO should be carried out. The high resolution plasma particle diagnostics and wave diagnostics located on board of DEMETER satellite can give us instantaneous high resolution description of high latitude structures and instabilities at a given point of space and time. On the other hand GPS permanent networks such as IGS and EPN(European Permanent Network) provide regular monitoring of the ionosphere in a global scale. Recently, TEC maps have been produced with 5 min intervals and with spatial resolution of 150 - 200 km. The FormoSat-3/COSMIC (Constellation Observing System for Meteorology, Ionosphere and Climate) is a joint scientific mission between Taiwan and the USA. The mission placed six small micro-satellites into six different orbits at 700~800 kilometer above the Earth's surface. Each micro-satellite payload includes Occultation Experiment dedicated to Radio Occultation (RO) measurements. Such global information based on the average size of ionospheric plasma parameters is supplemented by an analysis of instantaneous measurements of scintillation carried out at the Antarctic and Arctic IGS. In addition, the radio occultation technique is considered. The aim of this presentation is to discuss the behavior of large ionospheric structures during last long-lasting solar minimum

Recent Developments on the European Space Weather Portal (ESWeP)

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The European Space Weather Portal is an integrated website providing a centralised access point to the space weather community to share their knowledge and results. The portal has a large section devoted to education and outreach, but is also a platform to run local and remote models and to access their results in both graphical and various numerical forms.
During the ninth European Space Weather Week, we will show the new developments since last year: the updated SWWT pages, the UAH Space Weather Service, a list of recent articles in the Journal for Space Weather & Space Climate, the STCE Newsletters, future space weather events, a page about the EU FP7 and an interface to the COST Catalogue of European space weather assets.

Main Results for the ISS radiation Environment achieved during the COST ES0803 Project

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The space weather and the connected with it ionizing radiation have been recognized as a one of the main health concern to the International Space Station (ISS) crew. Estimation the effects of radiation on humans in ISS requires at first order accurate knowledge of the accumulated by them absorbed dose rates, which depend of the global space radiation distribution and the local variations generated by the 3D surrounding shielding distribution. The R3DE (Radiation Risks Radiometer-Dosimeter (R3D) for the EXPOSE-E platform on the European Technological Exposure Facility (EuTEF) worked successfully outside of the European Columbus module between February 2008 and September 2009. Very similar instrument named R3DR for the EXPOSE-R platform worked outside Russian Zvezda module of ISS between March 2009 and August 2010. Both are Liulin type, Bulgarian build miniature spectrometers-dosimeters. They accumulated about 5 million measurements of the flux and absorbed dose rate with 10 seconds resolution behind less than 0.41 g cm^{-2} shielding, which is very similar to the Russian and American space suits average shielding. That is why all obtained data can be interpreted as possible doses during Extra Vehicular Activities (EVA) of the cosmonauts and astronauts. The paper first analyses the obtained long-term results in the different radiation environments of: Galactic Cosmic Rays (GCR), inner radiation belt trapped protons in the region of the South Atlantic Anomaly (SAA) and outer radiation belt (ORB) relativistic electrons. The large data base was used for development of an empirical model for calculation of the absorbed dose rates in the extra vehicular environment of ISS at 359 km altitude. The model approximate the averaged in a grid empirical dose rate values to predict the values at required from the user geographical point, station orbit or area in geographic coordinate system. Further in the paper it is presented an intercomparison between predicted by the model dose rate values and data collected by the R3DE/R instruments and NASA Tissue Equivalent Proportional Counter (TEPC) during real cosmonauts and astronauts EVA in the 2008-2010 time interval including large relativistic electrons doses during the magnetosphere enhancement in April 2010. The model was also used to be predicted the accumulated along the orbit of ISS galactic cosmic rays and inner radiation belt dose for 1 orbit (1.5 hours) and 4 consequences orbits (6 hours), which is the usual EVA continuation in dependence by the longitude of the ascending node of ISS. These predictions of the model could be used by space agencies medical and other not specialized in the radiobiology support staff for first approach in the ISS EVA time and space planning.

Retrieval of Thermospheric Parameters from Daytime Ionospheric Observations at Geomagnetic Equator

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For the first time it is shown a principle possibility to retrieve basic thermospheric parameters (neutral temperature Tex , atomic [O] and molecular [O2] oxygen as well as molecular nitrogen [N2] concentrations) from observed electron density profile Ne(h) at the equatorial F2-region. The reduction of a 2D continuity equation for electron concentration in the low-latitude F2-region to the geomagnetic equator (I=0) results in a simple 1D equation which can be efficiently solved. The peculiarity of the proposed method is in using only the bottom side of the Ne(h) profile. This is important point keeping in mind the problems with Ne(h) topside approximation in the Digisonde observations. The method was tested using Jicamarca ISR and Digisonde Ne(h) profiles for the periods of CHAMP neutral gas density observations in the vicinity of the Jicamarca observatory. The retrieved from ISR Ne(h) neutral gas densities were shown to be close to the observed ones being within the announced absolute uncertainty of CHAMP neutral gas density observations 10-15% . The standard and mean relative deviations are: SD=0.445 and MRD=8.4% for the proposed method in a comparison with observations, while JB-2008 model gives SD=0.866 and MRD=30%, and MSISE-00 model provides SD=0.810 and MRD=27%. Acceptable results can be also obtained with Digisonde Ne(h) profiles but with less accuracy. The proposed method seems to open an opportunity to monitor the upper atmosphere using ground-based ionospheric observations.

The COST Example for International Collaborative Outreach to the General Public: I Love My Sun

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It is important to educate children about the important role that the Sun has in their lives. This poster presents an educational outreach tool entitled "I Love My Sun" that has been developed for school children in the approximate age range of 7 through 11 years.

The main objective of this tool is to make children aware of space weather, the Sun, Sun-Earth relations and how they, the children, are part of this global picture. Children are given a lecture about the Sun. The lecture is preceded and followed by the children drawing a picture of the Sun. In this paper the background behind the "I Love My Sun" initiative is given and it is described how to perform an "I Love My Sun" event.

Impressions and main results from events in Turkey, Belgium, Ukraine and Serbia are presented.

HELIO Use Case 3: HELIO as a tool for space weather

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The Heliophysics Integrated Observatory (HELIO; www.helio-vo.eu), provides an infrastructure that can be used to better understand the effects that solar flares, coronal mass ejections (CMEs), solar energetic particles (SEPs), and high speed solar wind streams have on Earth and the near-Earth environment. To date, HELIO has not been tested as a tool for these purposes. Here, HELIO is used to study a number of periods of elevated space weather at Earth in order to identify its strengths and weaknesses. We study 9 periods during which L-band dropouts and scintillations were observed, including a particularly severe dropout, with a duration of ~10 minutes, which occurred on 2011 September 24. We find that dropouts were associated with large microwave bursts, while the majority of scintillations were associated with CMEs.

HELIO Use Case 2: The 100 CME Challenge

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Studying the propagation and impact of solar eruptive events and their various manifestations is of great importance for understanding and predicting space weather conditions in the heliosphere. The Heliophysics Integrated Observatory (HELIO) provides an interface that allows researchers to track coronal mass ejections (CMEs) from their source region on the Sun, to their effects in interplanetary space. The aim of this challenge was to use HELIO to track a large number of CMEs having an associated type II radio burst and possible flare site on disk, through interplanetary space via their detected impacts at various spacecrafts. This was achieved by generating a workflow that accessed the corresponding event lists and used a ballistic CME propagation model to predict each event's arrival time at the expected impact sites (e.g. L1 near Earth). This provided a timeframe for determining the in-situ parameters measured at the different spacecraft locations along the CME trajectory, and thus allowed us to combine the remote-sensing and in-situ data across multiple spacecrafts on a per-event basis for comprehensive analysis of the physics of their propagation and evolution.

HELIO Use Case 1: Heliospheric variability over the solar cycle

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The Heliophysics Integrated Observatory (HELIO; www.helio-vo.eu) is a research infrastructure designed to facilitate the discovery of features and events in the heliosphere, determine connections between these, and provide access to relevant data and metadata. Here, HELIO is used to study the occurrence and properties of features (e.g., active regions, filaments, coronal holes) and events (e.g., flares, eruptions, co-rotating interaction regions) through the solar cycle. This is achieved using SQL queries to the HELIO Event and Feature Catalogs and their combination with Taverna workflows.

Dynamic and heat Processes during August 5-6, 2011 magnetic Storm

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Institute of Ionosphere

The super strong magnetic storm began at 19:03 UT on August 5, 2011. The geomagnetic activity index K_p during the main storm phase was 8-, D_{st} = -113 nT. The solar wind radial velocity during the main phase varied within 570 - 620 km s$^{¨C1}$. The temperature of solar wind particles increased up to 6.4

- 10^5 K and their concentration N_{sw} ¡Ö 1.9
- 10^7 m$^{¨C3}$. The value of the interplanetary magnetic field (IMF) B_z component was -(15 - 18) nT, the value of the magnetic induction modulus of the IMF equaled 25 - 27 nT. The aurora activity index was *AE* ¡Ö 1740 nT. The value of Akasofu function was ε ¡Ö 37 GJ s$^{¨C1}$

Kharkov incoherent scatter radar (ISR) was used for the observations of ionospheric storm effects and of physical processes parameter modeling. Kharkov ISR is unique source of information about parameters and processes in ionospheric plasma in mid-latitude Europe.

Calculations of heat and particles flux values, values of input energy to electron gas data as well as thermospheric winds values, ion-electron and ion-neutral collision frequencies, heat conductivity and ambipolar diffusion tensors were carried out.

It is shown that the strong magnetic storm on August -6, 2011 led to a substantial modification of the dynamic and thermal regimes in the ionospheric plasma

Effects of Solar Activity on ESA's Science and Earth Observation Missions

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ESA/ESOC

Abstract

During the past twenty years ESA launched 16 Science and Earth observation missions. Most of them are controlled from ESOC in Darmstadt, Germany, and are still operational. These missions have a wide range of orbit characteristics: low Earth orbits, Earth bound orbits with high eccentricity between 240 km and 160,000 km altitude, missions at the Lagrange points L1 and L2 and inter-planetary missions. The operational history of the 19 spacecraft involved represents a large pool of data concerning solar activity influencing spacecraft operations.

This presentation reports on solar activity events which had operational impact as they affected the solar arrays, the on-board memories, the star sensors or the communication with the spacecraft. The possibility of counter measures and their required reaction time is discussed.